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National Instruments for Experiential Education

Product and Services Guide

Contents

National Instruments for Academia

National Instruments is committed to enhancing engineering and science education through experiential learning, an approach that helps educators prepare better future engineers and scientists by creating an effective and dynamic learning environment. Using hands-on labs to student design projects this approach helps bridge the gap between industry requirements and university learning, thereby improving the quality of engineering and science education.

National Instruments facilitates experiential learning by providing flexible software and modular hardware that work with mainstream computer technologies to help integrate theoretical concepts with real-world applications. NI refers to this powerful combination of software and hardware as Virtual Instrumentation, which gives engineers and scientists the ability to capitalize on the ever increasing performance of PCs and define their own solutions, whether in the classroom or in the research laboratory.

“For the things we have to learn before we can do, we learn by doing.” *- Aristotle*

National Instruments Arabia for Academia

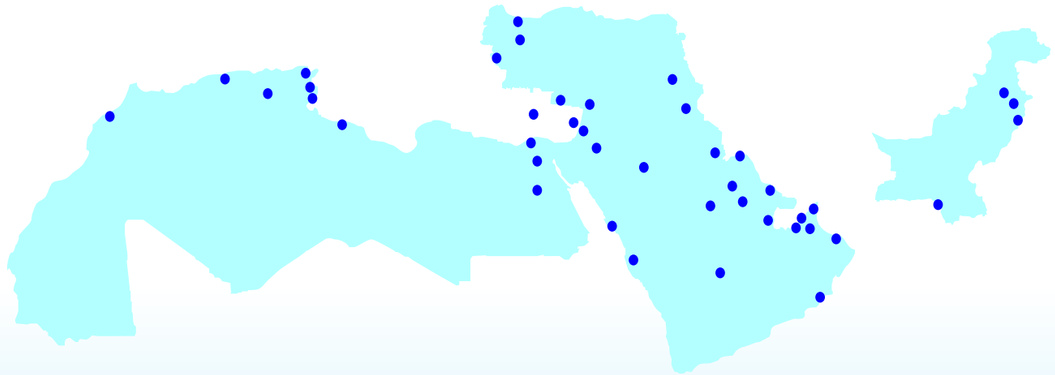
The National Instruments Academic Program in the region strives to improve the quality of science and engineering education across the region by facilitating experiential learning.

Throughout its history, National Instruments Arabia has collaborated with academia to develop Experiential Engineering Laboratories which are high quality teaching and learning environments. These Laboratories empower professors to better prepare students for today's engineering and science challenges by providing hands-on learning of fundamentals and concepts using the latest industry standard technologies.

Experiential learning using NI LabVIEW graphical programming and sophisticated hardware have continued to evolve as an ideal learning approach for a variety of engineering and science concepts and disciplines, including control and embedded design, signal and image processing, instrumentation, communications, biomedical, circuit design and others.

Education without Boundaries

Experiential Engineering Laboratories



With over a 100 Experiential engineering laboratories across Arabia, National Instruments is dedicated to providing a compelling undergraduate experience for science and engineering students

National Instruments offers a variety of multi-disciplinary Experiential Engineering Laboratory packages that will help you dramatically improve your teaching-learning environment. You can find out more information on the laboratories and the packages in any of the following ways:

- Refer the accompanying Laboratory Flyers
- Contact an NI Technical Consultant at:

Lebanon +961-1-332 828 Egypt +20-22-503 2845 Pakistan +92-51-2111135

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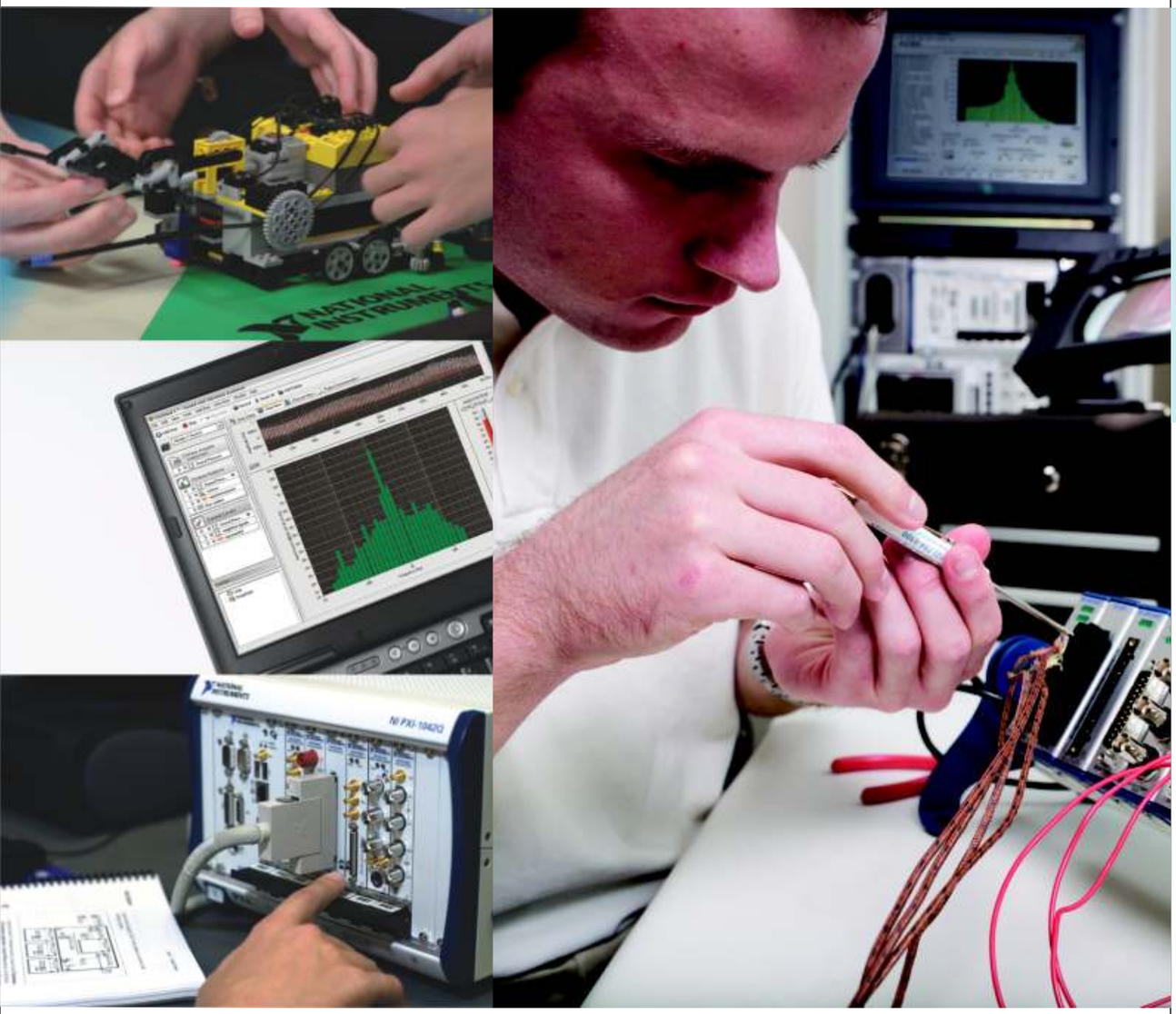
Tunisia & Maghreb : +216-200-38245

Email: ni.arabia@ni.com Web: www.ni.com/arabia

Academic Products and Services

Professors and students can take advantage of the integrated software and hardware offering from NI and improve hands-on learning in the curriculum. Professors can use seamless integration with NI software and hardware to teach a variety of application areas such as measurements, circuits, control, signal and image processing, communications, and embedded systems.



NI LabVIEW

NI LabVIEW is a graphical programming environment used on campuses all over the world to deliver project-based learning to the classroom, enhance research applications, and foster the next generation of innovators. Since the advent of NI LabVIEW in 1986, engineering educators have successfully integrated its easy-to-use, interactive interface and its powerful graphical system design capabilities into their curriculum for project-based learning and real-world, hands-on experiments.

Having evolved from a data acquisition and instrument control tool to an integrated graphical design platform, NI LabVIEW gives today's educators and researchers an intuitive graphical interface for teaching theory across engineering disciplines, performing design, simulation, prototyping, and deployment of custom designs to a range of hardware targets. NI LabVIEW also helps busy students and researchers work more efficiently by allowing them to write sophisticated programs and applications in a shorter amount of time without needing a computer science degree. After graduation, NI LabVIEW skills help students get jobs at thousands of companies around the world.

Top Reasons to Use NI LabVIEW for Teaching Engineering Concepts & Research Innovation

- Engineer Your Algorithms
- Discover Hands-On Project-Based Learning
- Increase Performance with Multicore Programming
- Take Measurements in Minutes with Tight I/O Connectivity
- Use Multiple Models of Computation to Solve Problems
- Analyze Signals with Built-In Math & Signal Processing Skills
- Visualize Your Data
- Reduce Development Time with Embedded System Design
- Save Time with Courseware
- Collaborate with a Worldwide Community of Engineers

Academic Options

NI Academic Site License: Get unlimited installations within a department, college, or campus, and automatic updates sent twice a year.

NI LabVIEW Student Edition

With NI LabVIEW, students can compute, simulate, and devise solutions to homework problems and design projects, and visualize concepts from textbooks.

ni.com/labview

NI ELVIS

The National Instruments Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) is an integrated design and prototyping platform for engineering and science laboratories to teach concepts in measurements, circuits, controls, microcontroller, and embedded design.

NI ELVIS integrates the 12 most commonly used instruments – oscilloscope, digital multimeter, function generator, bode analyzer, and more into a compact form factor ideal for the lab or classroom. Based on NI LabVIEW graphical system design software, NI ELVIS, with USB plug-and-play capabilities, offers the flexibility of virtual instrumentation and allows quick, easy acquisition and display of measurements. Designed with education in mind, NI ELVIS is a comprehensive tool for teaching everything from circuit design, digital electronics, instrumentation, controls, telecommunications, and embedded/MCU theory.

Researchers need the ability to develop prototypes rapidly as well as the flexibility to iterate on their design. Researchers can access the suite of 12 instruments found on NI ELVIS through the NI ELVISmx Instrument Launcher to make measurements with ease. For customization, researchers can take advantage of the flexibility of LabVIEW. In combination with the integrated instruments, the protoboard is ideal for efficiently constructing proof of concepts.

Top Reasons to Use NI ELVIS for Teaching Engineering Concepts & Research Innovation

- Component of the NI Electronics Education Platform
- 12 Integrated Instruments
- Powered by NI LabVIEW
- Distance Learning Platform
- Multidisciplinary Learning Platform
- Free Teaching Curriculum
- Teach Control Design Concepts with Ease
- Teach Telecommunications Concepts Instruments
- Teach MCU/Embedded Concepts
- Bioinstrumentation with NI ELVIS II and NI Multisim

ni.com/nielvis

NI Multisim

NI Multisim software integrates powerful SPICE simulation and schematic capture entry into a highly intuitive electronics lab on the PC. Based on professional printed circuit board (PCB) design tools, NI Multisim is designed for the needs of educators.

NI Multisim aids student understanding through features such as integrated quizzes, virtual and rated components, 3D virtual bread boarding, easy measurements, free curriculum and circuit sets from top textbooks, and more.

Educators can use NI Multisim to help students create "what if" scenarios with intuitive schematic capture and interactive simulation, develop intuition by using advanced SPICE analyses such as Monte Carlo and Worst Case, and experiment with designs in a risk-free 3D environment before going to the lab.

Top Reasons to Use NI Multisim for Teaching Engineering Concepts & Research Innovation

- Powerful and Easy-to-use Tools to Teach and Learn Circuit Theory
- Quick Circuit Design and Test
- Innovative Virtual 3D Breadboard
- Instruments for Real and Simulated Measurement Comparison
- Circuit Wizards for Automatic Generation of Commonly Used Circuitry
- Full Integration with NI ELVIS
- Education-specific Teaching Features
- 4,000 Common Laboratory Components

ni.com/multisim

NI PXI

NI PXI is the open, PC-based platform for test, measurement, and control. PXI provides the industry's highest bandwidth and lowest latency with modular I/O for high-resolution DC to 6 GHz RF. With more than 1,500 products from more than 70 vendors, PXI is the platform of choice for thousands of companies worldwide.

The NI PXI instrumentation platform for academia provides students and faculty with industry-standard, flexible instrumentation hardware and software for their measurement and automation needs. With this platform, which includes NI LabVIEW graphical system design software, educators and researchers have an industry-standard solution to teach and research with data from a variety of sensors and perform I/O operations to build sophisticated systems.

Features

- Modular architecture consisting of a chassis, controller and plug-in modules
- Chassis provides power, cooling and PCI / PCI Express communication buses
- Variety of chassis options such as low noise, high temperature, and low- to high-slot count
- PCI Express configurations allow for up to 4GB/s total throughput
- Integrated timing and synchronization with a dedicated 10 MHz system reference clock, PXI trigger bus, star trigger bus, and slot-to-slot local bus
- PXI Express provides the additional timing and synchronization features of a 100 MHz differential system clock, differential signaling, and differential star triggers
- Embedded and remote controller options from high performance to high value based on PXI / PXI Express
- OS support includes Windows 7/Vista/XP or LabVIEW Real-Time
- Designed for 24/7 operation in and temperature range of 0 to 55 deg C
- Large range of I/O modules from several vendors from basic data acquisition to modular instruments, motion and vision, communication, prototyping, processing, RF and more

National Instruments PXI Advantage:

For 13 years, NI has been the leader in PXI with a product portfolio of more that 400 modules as of today. This includes 48 new modules released in 2010 alone and a comprehensive offering of instrumentation from high-resolution DC to 26.6 Ghz RF measurements. In addition to measurement hardware, NI fully understands the importance of a robust and easy-to-use software framework, including development tools, instrument drivers, FPGA and Real-Time OS deployment tectnologies and other software-defined instrumentation capabilities.

ni.com/pxi

NI CompactRIO

The National Instruments CompactRIO programmable automation controller (PAC) is a low-cost reconfigurable control and acquisition system designed for applications that require high performance and reliability.

The NI CompactRIO embedded platform for academia provides deterministic, reconfigurable hardware and software for students and researchers focusing on embedded systems and control design. With an up to 3M gate FPGA-based backplane and a real-time controller, the CompactRIO embedded platform delivers loop rates up to 40 MHZ and deterministic execution of control algorithms.

Features

- Real-time Controller to Implement Time-critical Control Applications
- NI LabVIEW Control Design and Simulation Module, LabVIEW System Identification Toolkit
- Rugged, Reconfigurable Deployment Platform for Embedded and Control Applications
- Up to 40 MHz Loop Rates with FPGA-based Backplane
- Modular I/O Devices for Flexible I/O

ni.com/compactrio

NI LabVIEW Academy

With the growing demand for LabVIEW developers, the goal of the NI LabVIEW Academy is to greatly increase the supply of proficient and certified LabVIEW developers worldwide by empowering and enabling academic institutions to teach LabVIEW specific courses. The LabVIEW Academy program provides classroom curriculum and hands-on exercises to colleges and universities.

The LabVIEW Academy curriculum gives students the opportunity to validate their knowledge and skills at a professional level with certification. Experience and certification in LabVIEW can improve students' career opportunities around the world - providing graduates and potential employers with benefits such as:

- Reliable validation and demonstration of skills and knowledge
- Accelerated professional development, improved productivity, and enhanced field credibility
- Listing in the NI Certified Professionals database to demonstrate certification status

Experiential Engineering Platforms

NI Education Platform for Analog Electronics

Overview

The NI Educational Platform for Analog Electronics is based on the National Instruments Educational Laboratory Virtual Instrumentation Suite (NI ELVIS). It consists of an add-on circuit module, and is designed to help educators teach concepts related to analog circuits.

The module includes a prototyping area, where students can build their circuits, and features NI ELVIS II/II+ integration, which provides a complete instrumentation suite with 12 built-in instruments for building test benches with real-world signals to test their designs. All hands-on operations are conducted on the module. The circuits to be assembled are presented on respective front panels of each hands-on project, as well as in courseware manual. Corresponding sections of the manual are included in the software so that a student may review material on the related subject during the course of the practical work itself.

The platform includes a set of prewritten experiments to teach a variety of concepts related to analog electronics. Experiments are divided into two broad categories of DC and AC circuits. These introduce experiments in circuit fundamentals, Kirchoff's law, Ohm's laws and circuit topologies before moving on to resistive, capacitive and inductive components and networks. Because the module can be programmed with LabVIEW, educators can create their own labs and customize the system to match their individual learning objectives.

Concepts covered

DC circuits

- Voltage source in electric circuits
- Light sensitive resistors (photoresistors)
- Kirchhoff's circuit laws
- Electric power, performance factor, source and load matching
- Ohm's law
- Series and parallel connection of resistors
- Resistive voltage dividers
- Temperature sensitive resistors (thermistors)
- Voltage dependent resistors (varistors)
- Charging and discharging of capacitors

Features

- Based on the NI ELVIS platform which integrates 12 most commonly used instruments - including oscilloscope, digital multimeter, function generator, bode analyzer, and more – in a compact form factor
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- Includes manuals and procedures for 15 complete experiments to teach various concepts in optical fiber communications and technology
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Interactive representation of circuits in each hands-on project in a graphical format to make circuit implementation easier
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module
- Built-in safety measures

Applicable Courses

- Basic Electronics
- Analog Electronics
- Circuit Theory

References

• King Fahd Univeristy of Petroleum & Minerals • King Saud University
• Al Faisal University • Bahrain Polytechnic • Khalifa University
• Canadian University of Dubai •Texas A&M Qatar

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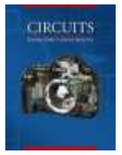
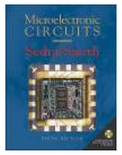


Circuits

Fawwaz Ulab and Michel Maharbiz

NTS press



Microelectronic Circuits

Adel S. Sedra and Kenneth C. Smith,

Oxford University Press

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NI Education Platform for Digital Electronics & FPGAs

Overview

The NI Educational Platform for Digital Electronics & FPGAs is based on the National Instruments Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) and LabVIEW FPGA. It is designed to give students an understanding of concepts in digital electronics as well as FPGAs and their application areas.
The hardware platform consists of a Xilinx Spartan-3E field-programmable gate array (FPGA) board, and is designed to help educators teach digital electronics design concepts. The board is fully programmable with both NI LabVIEW software and the LabVIEW FPGA Module as well as Xilinx ISE tools, so educators can teach digital electronics for all disciplines.

LabVIEW FPGA is used to teach the basic concepts in digital electronics which can then be studied by implementing these designs on the circuit board. LabVIEW FPGA offers a completely new design flow for FPGA targets, and provides a unified and comprehensive environment for hands-on laboratory projects in digital circuits and systems. The graphical dataflow paradigm and LabVIEW programming environment offer many advantages over traditional HDL-based design flows, not only in terms of design entry, but for simulation, real-time debugging on the target, and host-to-FPGA communications.

The system includes a prototyping area, where students can build their circuits, and features NI ELVIS II/II+ integration, which provides a complete instrumentation suite with 12 built-in instruments for building test benches with real-world signals to test FPGA designs. The board also includes the necessary peripherals such as LEDs, DIP switches, push buttons, seven-segment displays, and encoders for teaching digital electronics concepts.

The platform includes a set of prewritten labs to teach both basic and advanced concepts of digital electronics. Because the module can be programmed with LabVIEW, educators can create their own labs and customize the system to match their individual learning objectives.

Students learn basic logic, sequential logic, truth tables, Karnaugh maps (K-maps), and theorems. The hands-on lab exercises, implemented using LabVIEW, help students use theory to implement real-world objectives like pulse-width modulation, binary-coded decimal conversion, quadrature encoders, and state machines. Because LabVIEW FPGA is easily integrated with hardware, students compile, test, and run their code directly on the academic Xilinx Spartan 3E Starter Kit

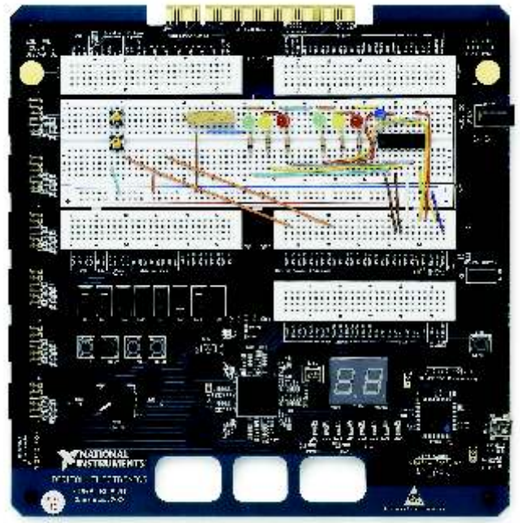
Concepts covered

Digital Electronics

- Logic Fundamentals
- Karnaugh Maps
- Combinatorial Devices, binary-to-BCD Converter and sequential logic devices
- Pulse-width modulation
- Quadrature encoding
- Finite State-Machines

Digital Circuits (using LabVIEW FPGA or Verilog)

- Minority gate design
- Sequence Detector circuit design
- Clock dividers
- Combinatorial circuits
- Programmable counter circuit design
- Memory Design



Features

- Includes FPGA board with NI ELVIS platform which integrates 12 most commonly used instruments – including oscilloscope, digital multimeter, function generator, bode analyzer, and more – in a compact form factor
- Circuits can be designed in software and then directly downloaded on to the FPGA target to verify their working
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- Includes manuals and procedures for complete experiments to teach various concepts in optical fiber communications and technology
- Courseware continuously updated with new revisions available for free download
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module

Applicable Courses

- Digital Electronics
- Logic Design
- Basic Electronics
- FPGA courses

References

- Bahrain Polytechnic
- Qatar University
- Texas A&M University Qatar

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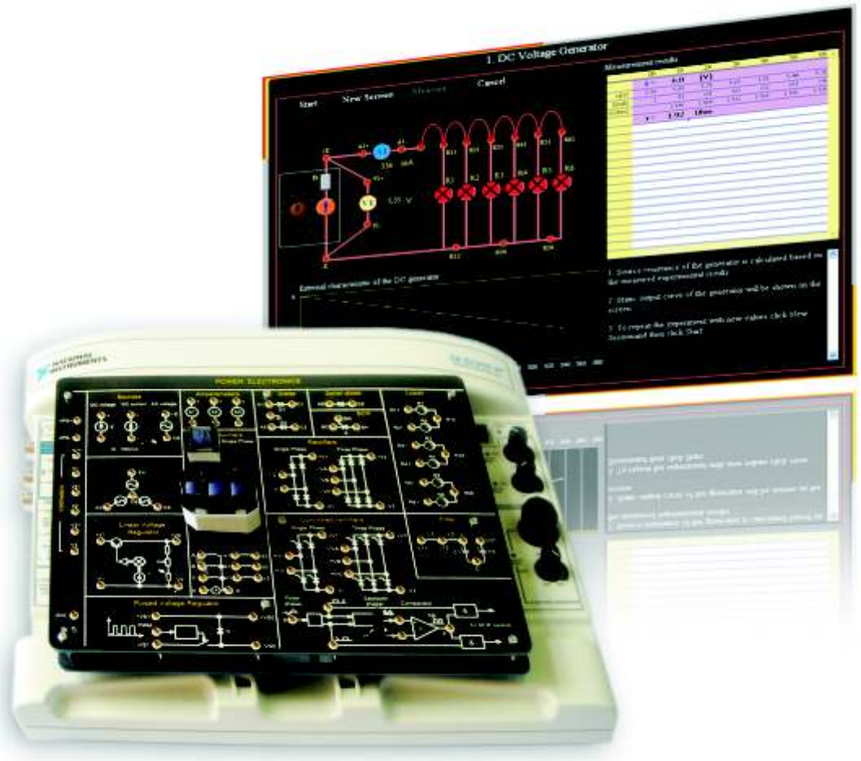
NI Education Platform for Power Electronics



Overview

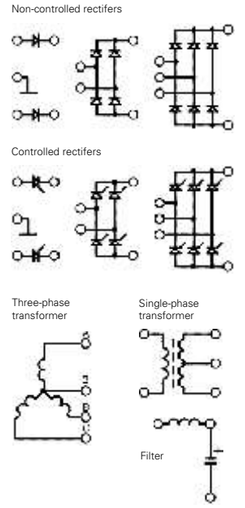
Power electronics is the application of solid-state electronics for the control and conversion of electric power. Power electronic converters can be found wherever there is a need to modify a form of electrical energy (i.e. change its voltage, current or frequency). The power range of these converters is from some milliwatts (as in a mobile phone) to hundreds of megawatts (e.g. in a HVDC transmission system). With "classical" electronics, electrical currents and voltage are used to carry information, whereas with power electronics, they carry power.

The NI Education Platform for Power Electronics (transformers, rectifiers and voltage regulators) is based on the NI ELVIS and uses software developed using NI LabVIEW. The NI ELVIS platform uses different plug-in modules that enable a hands-on approach to teaching introductory concepts in electronics and telecommunication and uses a similar module for power electronics.

All hands-on operations are conducted on a preassembled printed circuit board with 14 different circuits. The students can study the operating principles of voltage and current regulators, DC-AC and DC-DC converters; measure the operational characteristics of AC voltage- and current generators. The students can also study the parameters of single-phase and triphase transformers and rectifiers, as well as diodes, Zener diodes and SCRs. The course manual is embedded in lab software for easy access to ad-hoc theoretical material during the lab. Experimental results, including student name, date & time, etc. may be exported and saved in MS Excel or any other desired format.

Concepts covered

- Characteristics and operation of DC & AC voltage generators
- Operational characteristics of DC current generators
- Operational characteristics of linear voltage regulators (current & voltage instability), switching voltage regulators and switching voltage regulators with filter
- Characteristics and operation of SCRs
- Principles and working of Zener diodes
- Characteristics of single-phase transformers in idle running and short-circuit modes and with active loads
- Operational characteristics of single-phase rectifiers with and without a filter
- Characteristics of three-phase networks and transformers in star/delta and star/star connection
- Operational characteristics of single-phase and three-phase controlled rectifiers with active load

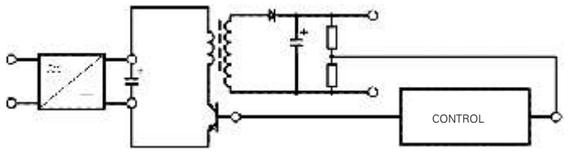


Features

- Includes manuals and procedures for 17 complete experiments to teach various concepts in power electronics
- Based on the NI ELVIS platform which integrates 12 most commonly used instruments – including oscilloscope, digital multimeter, function generator, bode analyzer, and more – in a compact form factor
- Fully customizable experiments, design your own experiments and create custom problems
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module

Applicable Courses

- Power Electronics
- High Voltage circuits and systems



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LabVIEW for Electric Circuits, Machines, Drives, and Laboratories

Nesimi Ertugrul, University of Adelaide

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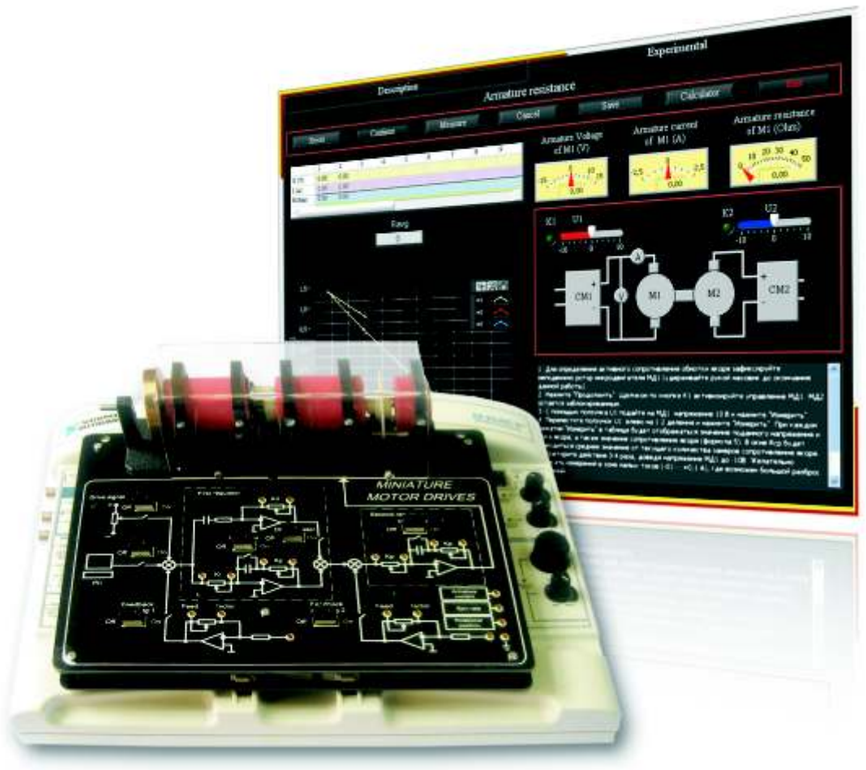
NI Education Platform for DC Motors



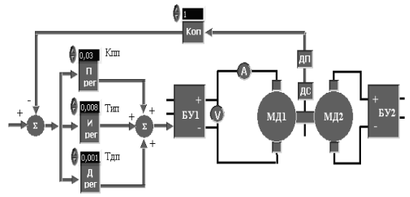
Overview

The NI Education Platform for DC Motors is based on the NI Electronics Laboratory Virtual Instrumentation Suite (NI ELVIS) and uses software developed using NI LabVIEW. The NI ELVIS platform uses different plug-in modules that enable a hands-on approach to teach concepts in electronics and telecommunication and uses an add-on module that enables the study of micromotors and miniature motor drives

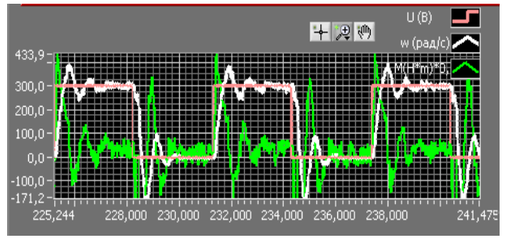
The add-on module facilitates hands-on learning and includes 14 complete experiments. The students can study the mechanical and static characteristics of DC motors in an open system with software-controlled power supply. All hands-on projects are conducted on the add-on module to the NI ELVIS platform. Students can study the output signals of the circuits depending on the input stimulus. A comprehensive course manual is embedded into the software for easy access to ad-hoc theoretical materials during the lab.

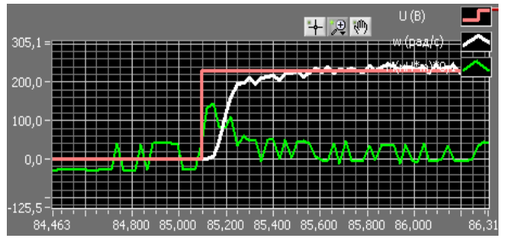
Concepts covered

- Armature resistance & electromechanical conversion factor
- Mechanical and operational characteristics of DC motors
- Static speed-torque characteristics of a single-loop control system with regulators
- Dynamic characteristics of an open-loop DC motor control system
- Dynamic characteristics of a single-loop & double-loop DC motor control system and angular position control



Single-loop system for PID control of angular position of the rotor





Transitory processes in the angular position control system

Features

- Includes manuals and procedures for 14 complete experiments to teach various concepts related to characteristics and working of DC motors
- Based on the NI ELVIS platform which integrates 12 most commonly used instruments – including oscilloscope, digital multimeter, function generator, bode analyzer, and more – in a compact form factor
- Fully customizable experiments, design your own experiments and create custom problems
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module

Applicable Courses

- DC Machines
- Electric Machines

View suggested textbooks at ni.com/textbooks

LabVIEW for Electric Circuits, Machines, Drives, and Laboratories

Nesimi Ertugrul, University of Adelaide

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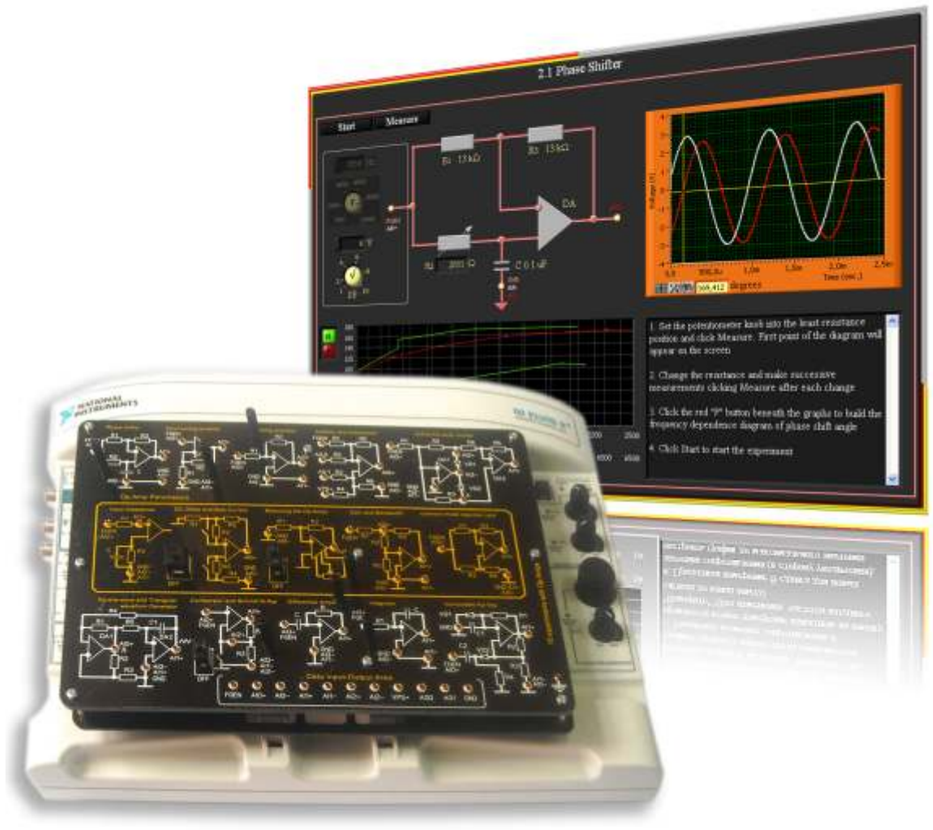
NI Education Platform for Operational Amplifiers



Overview

An operational amplifier or op-amp is a DC-coupled high-gain electronic voltage amplifier with a differential input and, usually, a single-ended output. An op-amp produces an output voltage that is typically hundreds of thousands times larger than the voltage difference between its input terminals. Op-amps are among the most widely used electronic devices today, being used in a vast array of consumer, industrial, and scientific devices.

The NI Education Platform for Operational Amplifiers is based on the NI ELVIS and uses software developed using NI LabVIEW. The NI ELVIS platform uses different plug-in modules that enable a hands-on approach to teach concepts in electronics and telecommunication and uses an add-on module that enables the study of op-amps.

The platform has been developed for hands-on measurement of 5 basic parameters of Operational Amplifiers and study of 10 most common application circuits. All hands-on projects are conducted on the add-on module to the NI ELVIS platform. Students can study the output signals of the circuits depending on the input stimulus. A comprehensive course manual is embedded into the software for easy access to ad-hoc theoretical materials during the lab.

Concepts covered

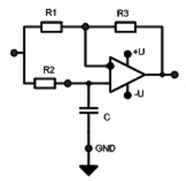
Op-Amp Parameters

- Input impedance
- Bias current and voltage
- Output balancing
- Gain and bandwidth
- Common mode rejection ratio

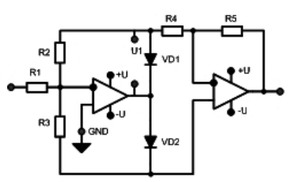
Application Circuits for op-amps

- Phase shifter
- Non-inverting amplifier
- Inverting amplifier
- Addition and subtraction of analogue signals
- Active full-wave rectifier
- Square- and triangular waveform generator
- Comparator. Schmitt flip-flop
- Differentiating circuit
- Integrating circuit
- Biased multi-vibrator (univibrator)

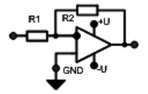
Phase shifter



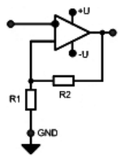
Active full-wave rectifier



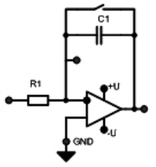
Inverting amplifier



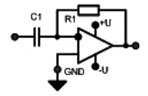
Non-inverting amplifier



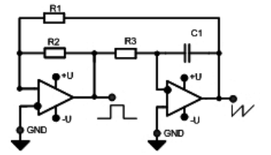
Integrating circuit



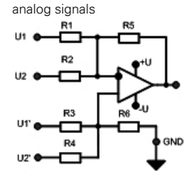
Differentiating circuit



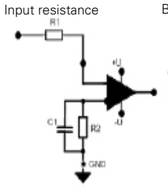
Square wave and sawtooth generator



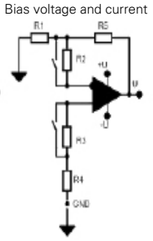
Addition and subtraction of analog signals



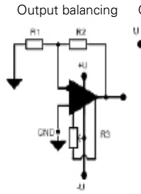
Input resistance



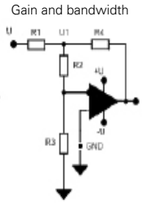
Bias voltage and current



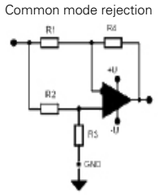
Output balancing



Gain and bandwidth



Common mode rejection



Features

- Includes manuals and procedures for 15 complete experiments to teach various concepts related to characteristics and applications of op-amps
- Based on the NI ELVIS platform which integrates 12 most commonly used instruments – including oscilloscope, digital multimeter, function generator, bode analyzer, and more – in a compact form factor
- Fully customizable experiments, design your own experiments and create custom problems
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module

Applicable Courses

- Analog Electronics
- Circuit Theory
- Basic Electronics

References

Khalifa University

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NI Education Platform for Automated Test and Analog & Digital Measurements

Overview

The study of various analog and digital measurements and parameters is essential when building test systems. A range of measurements are made using several different instruments, the results of these are used to characterize the behavior of components and systems.

The NI Educational Platform for Automated Test includes a combination of an open hardware platform based on PXI, along with a suite of modular instruments, as well as a set of Device Under Test (DUT) boards to allow for the study of various parameters.

The platform is designed to give the engineering student hands-on experience with measurement equipment and data acquisition software and hardware that go into the building of test systems as well as several common measurements made in the hardware testing domain.

The platform uses a Mixed-Signal demo box with interchangeable DUTs and the following instruments in the PXI chassis : High-Speed Digital Waveform Generator/Analyzers (HSDIO), Arbitrary Waveform Generators, Digitizers (oscilloscopes), Digital Multimeters (DMMs), Voltage and current data acquisition, Switches, and controlled precision power supplies (Source Measure Units)

Three DUTs are included with the system. These are:

The Mixed Signal DUT which has digital-analog and analog-digital converters and filters which can be tested and their parameters measured.

The High-Speed Digital DUT board which contains a CPLD (custom programmable logic device) chip. It can be programmed with various personalities to emulate different electronic components to be tested. The board also has an I2C temperature sensor and external connectors for transmission of digital signals.

The Chip Test DUT board which has an FPGA chip (Cyclone II EP2C5F256). Tests for all kinds of manufacturing defects (such as short circuit or poor connection) are performed on its pins. Another series of tests measures AC and DC parameters of the pins, such as power consumption, logical input and output levels and so on.

The Mixed Signal Demo Box software is a unified interface for the whole platform which is used to launch all testing and measurement applications for each DUT board.

Concepts covered

Mixed Signal DUT

- INL/DNL analysis
- Total Harmonic Distortion (THD)
- High-speed DAC analysis
- Power consumption measurement
- Band pass filter characterization

High Speed Digital DUT

- Bit Error Rate Test (BERT)
- I2C bus test
- Analog waveform analysis of a digital signal
- Functional Memory Tests
- Memory Characterization
- DC Parametric Tests
- Poor connection/Short circuit tests

Chip Test DUT

- Poor connection/Short circuit tests
- Dinamic consumption current
- Logical input levels
- Input leakage currents
- Logical output levels
- Output short circuit test

Features

- Versatile data acquisition system, with plug and play modules, which can be configured to build multiple measurement systems
- Industry standard platform with inbuilt modular instruments to perform a whole range of measurements
- Included Device-Under-Test boards help study various circuits, fault conditions and understand testing parameters
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- Leverages industry grade systems so that students learn on systems which are currently used in the industry

Applicable Courses

- Data acquisition
- Automated Test
- Instrumentation

References

Prince Mohammad University

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NI Education Platform for Electric Machines

Overview

The NI Education Platform for Electric Machines provides a complete range of integrated hardware and software for the various subjects of AC, DC machines and transformers in education and research. The common objective guiding the design of this equipment is the development of tools that are the core of a training and research program about the latest manufacturing and service technologies and techniques in the industry. In following these programs the students acquire theoretical knowledge and practical experience on machines and software that are of industrial type arranged in a way to give maximum learning profitably to them.

The flexible and modular design using LabVIEW and National Instruments hardware enables students, researchers and professors to select a wide range of electric machines simulations, measurements and control methods, varying in complexity from simple motor load test, up to fully automated LabVIEW based Hardware In the Loop measurement and control system. Following the same trend, and using LabVIEW, professors and researchers can design their own experiments and conduct research at graduate level.

National Instruments is working with leading manufacturers to design electrical machines and power electronics that takes uniquely industrial standard into consideration. Since very small electrical machines give unrealistic measuring values, we have carefully considered this by optimizing the winding data of the machines and by choosing an effect of approx 1 KW.

An experiment manual is provided, which contains for each experiment theoretical review, circuit diagrams, experiment execution procedure in a step by step approach. All experiments run into LabVIEW, which gives a great flexibility to do more analysis on the signals and data logging.

The lab consists of the following workstations:

- NI PXI based DC Motor-Generator System
- NI PXI based Asynchronous Motor-Generator System
- NI PXI based Synchronous Motor-Generator System
- NI PXI based Transformers test System
- NI PXI based Single Phase Machines System

A manual supplied with each system describes in details the electrical connections to the NI PXI system and the mechanical assembling procedure.

Concepts covered

- Electrical and mechanical characteristics of a shunt and separate excitation DC motors
- Speed control and behavior of DC machines
- Study of a DC generator
- Electrical and mechanical characteristics of the squirrel cage asynchronous (AC) motor
- Varying speed characteristics of AC machines
- Electrical and mechanical characteristics of a synchronous (SM) motor
- Characteristics of three-phase synchronous generator
- No load and short circuit test for transformers
- Determination of transformer polarity, efficiency and other parameters
- Characteristics of a Single Phase Universal and Cap Run Motor

Features

- Open platform with industry standard hardware and software
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Single chassis with complete set of instruments – voltage and current acquisition, switching, programmable power supplies, digital multi-meter and signal generator
- Includes DC machine, three phase machine, transformer test bench, universal and cap run motors, variable frequency drive, braking generator, along with speed, torque sensors and programmable loads
- Consists of an Electrical Panel with fixed three phase AC voltage output, variable DC voltage output, Fixed DC voltage output, variable resistive and inductive loads manual and PXI control interface
- Inbuilt features for safety and protection using breakers, fuses, contactors and so on
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual
- Leverages industry grade systems so that students learn on systems which are currently used in the industry
- Data is presented in customizable visualizing formats and can be exported to tools such as Microsoft Excel or Adobe Acrobat if needed

Applicable Courses

- Electrical Engineering courses
- Machines lab

References

Bahrain Polytechnic

View suggested textbooks at ni.com/textbooks

Electrical Engineering, Principles and applications

Allan R. Hambley

Prentice Hall

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Electronics & Instrumentation Labs at Khalifa University

Abstract:

Facilities to teach undergraduate engineering students concepts in Electronics and Instrumentation Engineering across two different campuses using NI ELVIS with NI Multisim and NI LabVIEW.

Products Used:

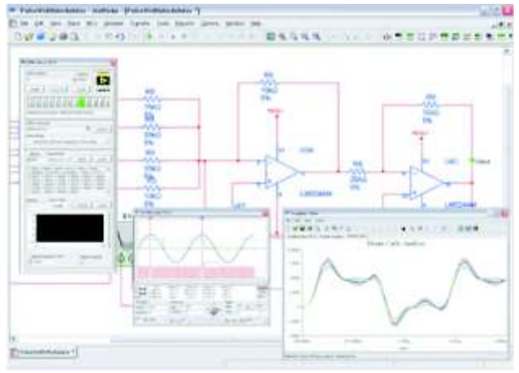
NI ELVIS, NI Multisim, NI LabVIEW

Details:

Khalifa University has undergraduate engineering programs for Electronics Engineering and in the first and second year, there are mandatory laboratory courses required for students to take up.

In order to augment the theoretical coursework with real-world hands on experiments, they chose to use NI Multisim with the NI Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) systems. Students first design circuits using the NI Multisim environment and these can then be directly built on the breadboard available on the NI ELVIS.

The NI ELVIS which contains an integrated suite of 12 of the most commonly used instruments including an oscilloscope, multimeter, dynamic signal analyser, impedance analyser, bode analyser, current and voltage anaylysers and several more is used to make measurements of various parameters from the circuits assembled on it. This data is available on the PC and students can compare the results of practical experimentation with that obtained from theoretical calculation.



Topics covered include basics of analog electronics including basic circuits both AC and DC as well as circuit elements such as resistors, capacitors and inductors and networks using this elements. The courseware contains multiple chapters that illustrates how the NI ELVIS can be used with NI Multisim and NI LabVIEW covering a range of topics from introductory level exercises to design challenges. The experiments are designed to introduce those who are new to the NI ELVIS platform to the many features and possibilities that exist in both hardware and software. The courseware begins with an introduction to the NI ELVIS workspace, and eventually steps users through nearly all of the instruments available in the NI ELVIS software. Additionally, most experiments also include VIs meant to expand the boundaries of the experiments into LabVIEW programming. Experiments begin with a blank protoboard and use the most common components typically found in an introductory circuits lab.These facilities are used by over 50 students simultaneously in multiple laboratories and locations at the University.

Digital Systems & Microprocessors Laboratory at Qatar University

Abstract:

The Digital system design and Microprocessors laboratory aims to give the electrical engineering students sufficient experience to implement what they have learned through theoretical courses practically as well as equip them with the design, analysis and troubleshooting of digital circuits skills and use microprocessors in a lot of practical applications.

Products Used:

NI LabVIEW, NI Multisim, NI ELVIS, FPGA and Microcontroller Trainers

Details:

The lab supports the following laboratory courses in the Electrical Engineering Department,

- ELEC 262 (Digital System Design Laboratory)
- ELEC 263 (Computer Architecture and Organization Laboratory)
- ELEC 365 (Microprocessors Laboratory)
- ELEC 456 (Digital Signal Processing Laboratory)
- ELEC 201 (Electric Circuits Laboratory)
- ELEC 203 (Electric Circuits 2 Laboratory)
- ELEC 332 (Electronics Systems Laboratory)
- ELEC 334 (Electronics Systems 2 Laboratory)

Core teaching topics are in the following areas:

1. Correct methods for measuring various electrical parameters.
2. Verification of ohm's law, KVL, KCL to series or parallel circuits.
3. Confirmation of mesh analysis, nodal analysis, source transformation, superposition theorem, Thevenin's theorem, Norton's theorem and maximum power transfer theorem for both ac and dc sources.
4. Verification of characteristic equations of step and source free transient response first and second order circuits.
5. Characterization of different semiconductor devices such as diodes, BJT's and FET's.
6. Verification of time response plots of half wave and full-wave rectifiers, clipping and clamping circuits.
7. Application of operational amplifiers for linear and non-linear circuits such as negative feedback amplifiers, instrumentation amplifiers, voltage to current converters, phase shifters, active filters, relaxation oscillators and waveform generators.

Conclusion:

Realization of a conceptual design is probably one of the most fulfilling experiences of every engineering student. In the advent of computer technology, the implementation of an electrical or electronic systems design has been revolutionized through the use of various computer simulation and hardware interface tools. Students should not only learn the theory and concept, but in order to become competitive and marketable, they should also know the tools and methods on how they can implement their design using the latest technology. The purpose of this lab to create this hands on learning experience has been successfully achieved.

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NI Education Platform for Process Control

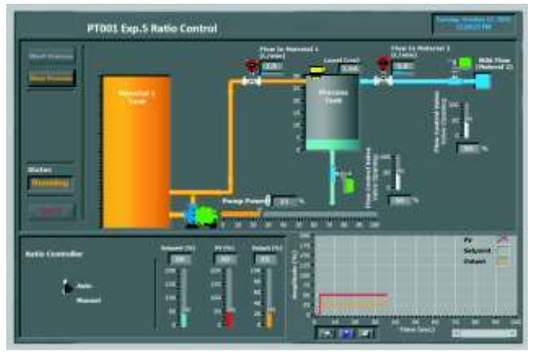
Overview

Process control is a statistics and engineering discipline that deals with architectures, mechanisms, and algorithms for controlling the output of a specific process. This laboratory facility has been developed to study and understand the various concepts and principles of Process Control engineering by means of practical experiments.

The hardware setup consists of a computer based, bench-mounted Process Trainer, which includes different sensors required for measurement of process parameters such as temperature, pressure, level and flow control. It also consists of various actuators and control valves, along with heaters and pumps, where in the behavior of these actuators is controlled based on the process variable input obtained from the sensor.

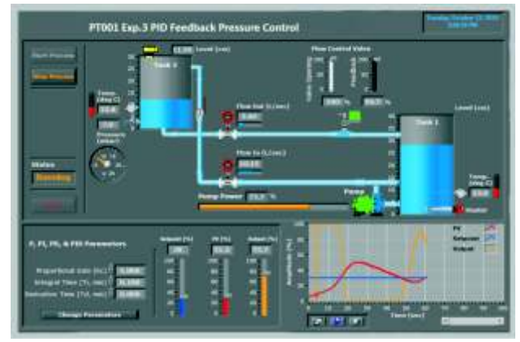
Using this trainer, different conditions of a real-world process can be simulated; level of liquid in two independent reservoirs is controlled by means of pumps and flow from one to the other, by means of valve control.

Data acquisition from all the sensors and control of the actuators is achieved by means of the National Instruments Compact RIO based Industrial Controller, which consists of a reconfigurable FPGA running the process control algorithm, as well as several I/O modules which interface with the sensors, valves, heaterand pump.



The Compact RIO system is programmed by means of a graphical user interface, based on National Instruments LabVIEW. The user can set different values for various parameters, and study the response of the system by means of discrete indicators as well as graphs in order to understand trends. A whole range of analysis functions are available to further analyze the date obtained and understand the underlying principles of the entire process.

Concepts covered



- Acquisition of physical phenomena
- Study of interacting & non-interacting systems
- On/Off and PID based control (response & tuning)
- Setpoint Profile Generation
- Lead-Lag Compensation
- Feedback/Feedforward Control
- Multiloop Cascade Control ; Ratio Control
- Closed loop response of temperature, pressure, flow and level control loops

Features

- Process trainer with liquid reservoirs and integrated sensors, control valves and actuators
- NI Compact RIO reconfigurable industrial controller for data acquisition and actuator control with inbuilt FPGA used to store and execute control algorithms and Real-Time OS for data acquisition and system control.
- Easy to use open graphical programming software with buttons and dials for set-point control as well as graphs and indicators to view output
- Completely customizable experiments, design your own experiments and create custom problems to be solved
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints

Applicable Courses

- Process control Engineering
- Control Design / Control Theory
- SCADA systems
- Mechanical control systems
- Manufacturing / Industrial control
- Embedded systems & data acquisition

References

- Prince Mohammad University
- King Fahd Univeristy of Petroleum &
- Minerals, Bahrain Polytechnic

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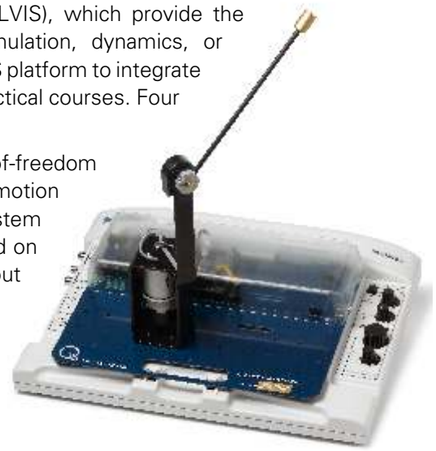
NI Education Platform for Controls

Overview

The NI Education Platform for Controls includes a set of add-on trainer modules, used with the NI Educational Laboratory Virtual Instrumentation Suite (NI ELVIS), which provide the components you need to set up your control design, simulation, dynamics, or thermodynamics lab. These modules are used with the NI ELVIS platform to integrate the NI LabVIEW Control Design and Simulation Module into practical courses. Four trainer modules are included. These are:



The Vertical Take-Off and Landing (VTOL) Trainer is a 1 degree-of-freedom (1DOF) helicopter that provides a fundamental introduction to motion control, aerospace dynamics, kinematics, and control. The system consists of one variable-speed fan with safety guards, mounted on the end of a cantilevered arm. The fan and arm assembly pivot about an axis attached to an encoder shaft.

The DC motor control Trainer is designed to illustrate the fundamentals of DC motor control using the NI ELVIS workstation and LabVIEW software. Students can quickly and easily configure it to control motor position and speed as well as parameter estimation and haptics knobs.

The Rotary Inverted Pendulum Trainer offers students the opportunity to balance a vertical rod at the tip of a rotating arm using a DC motor. They can now perform this classic inverted pendulum control experiment using the NI ELVIS workstation and LabVIEW software.

The HVAC Trainer is ideal for illustrating concepts covered in fluid dynamics and thermodynamics control courses. It teaches students how to design a control system that regulates temperature in a chamber using the NI ELVIS workstation and LabVIEW interface. The trainer features a chamber equipped with a temperature sensor, heat source, and fan.

Concepts covered

Vertical Take-Off & Landing Trainer

- Flight dynamics, (e.g. modeling the plant)
- Identifying parameters experimentally
- Model validation
- Proportional–Integral–Derivative (PID) control
- Cascade control
- Dealing with actuator dynamics
- Disturbance Rejection

DC Motor Control Trainer

- System modeling
- Model validation
- Position and speed control
- System simulation
- Proportional–Integral–Derivative (PID) Control design
- Tracking error
- Disturbance rejection

Rotary Inverted Pendulum Trainer

- System modeling
- Parameter estimation
- Balance control
- Linear-Quadratic Regulator (LQR) design
- Non-minimum phase
- Friction compensation
- Nonlinear swing-up control
- Energy-based design
- Hybrid balance / swing-up control

HVAC Trainer

- Temperature control
- Relay / on-off control design
- System modeling
- Parameter identification
- Proportional–Integral (PI) control design

Features

- Includes manuals and procedures for complete experiments to teach various concepts in controls using the different trainers
- Based on the NI ELVIS platform which integrates 12 most commonly used instruments – including oscilloscope, digital multimeter, function generator, bode analyzer, and more – in a compact form factor
- Fully customizable experiments, design your own experiments and create custom problems
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module
- Systems are compact and easy to store with a plug-and-play design to allow quick and easy setup
- The Vertical Take-Off and Landing trainer includes a high quality rugged propeller assembly with a variable-speed fan with safety guard and a high resolution encoder
- The DC Motor trainer features a durable DC servo motor with built-in power amplifier and a high resolution optical encoder to sense position
- The Rotary Inverted Pendulum trainer uses a documented energy based-swing up control design based on the pendulum link model and includes a durable DC servo motor with precise and stiff machined components. It also has a built-in power amplifier, high resolution optical encoders to sense positions and features a fully document system model and parameters
- The HVAC Trainer features a transparent chamber with a durable fan to provide cooling, a 12V halogen lamp as the heat source and an integrated electronic temperature sensor

Applicable Courses

- Control systems and engineering
- Electrical engineering
- Flight control basics
- HVAC systems

References

- Bahrain Polytechnic
- Jubail Industrial College
- Kuwait University
- NUST SEECS Pakistan

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NI Education Platform for Motion Control & Gears

Overview

The NI Education Platform for Motion Control & Gears is based on the NI CompactRIO real-time systemand uses software developed using NI LabVIEW. The platform facilitates hands-on study of DC motor drive in various modes, high-speed motion control, dynamic load imitation and vibration diagnostics of rotary gear mechanisms. The hardware setup consists of two DC motors linked to each other by a set of gears. One of the motors drives the system while the other is imitates the load or operates as a generator.

The platform allows for the study of DC motor control algorithms (constant revolutions, constant torque, smooth start-up and halting, revolutions changing by given law), investigate the generator output signal vs. rotation speed. Means are provided for vibration diagnostics (spectral, octave and sequential analysis), identification of vibration resonances, diagnosing vibration sources in gear transmissions, correlation between sequential spectra and number of notches and transmission coefficients of gears. A comprehensive course manual is embedded into the software for easy access to ad-hoc theoretical materials during the lab.

Concepts covered

- High-speed motion control (On-off control, PWM)
- Measurement and processing of sensor data (revolution counter, accelerometer)
- Automatic control and regulation of rotary speed (PID control)
- Vibration analysis and diagnostics of gear box

Features

- Includes manuals and procedures for 4 complete experiments to teach various concepts related to characteristics and working of DC motors
- Fully customizable experiments, design your own experiments and create custom problems
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module

Applicable Courses

- DC Machines
- Electric Machines
- Automotive Engineering

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Process Control Lab at Jordan University of Science & Technology

Abstract:

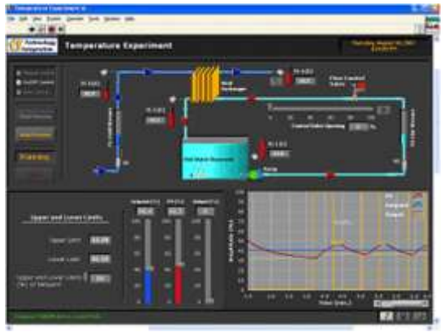
Computerizing a 15 years old Control Lab in the Chemical Eng. Dept. of Jordan University of Science and Technology (JUST). The goal was to computerize the existing trainers by keeping their consoles while changing both the control system and the interface to the student.

Products Used:

NI Real Time Controller and I/Os, NI LabVIEW, and Report Generation Toolkit.

Requirements:

- Connecting 3 Trainers to one networkable control system
- Use the existing consoles and their sensors
- Experiments to be Computerized:
  - Temperature Experiment
  - Level Experiment
  - Pressure Experiment
- Maintain the operation and curriculum covering manual, on/off and PID control and sensor calibration
- Data processing and reporting facility for the student by printing and exporting data and charts to Excel
- Process Animation and Simulation on the Screen
- Automatic Safety handling by the system.



Solution and benefits:

The computerization of the lab was performed by connecting all I/O from all three experiments to one NI controller. Each experiment ran independently and all three experiments ran simultaneously at the same time.

The system became very user friendly, in a manner that would enable the students to get better understanding of the curriculum. The student can save the experiment data at the end of the lab and take it home on an excel file for analysis.

Updating the lab was cost efficient and did not exceed the tight university budget.

The Lab Administrator feature allowed faculty to be able to monitor the student's experiment console from his office using LabVIEW Web Publishing Tool.

Nanopositioning Servo Control using Piezoelectric Actuators

Abstract:

This project aims to study the properties of piezoelectric (PZT) actuators to achieve a highly precise positioning system in nanometer scale. The experimental setup to validate and to verify the developed control algorithms consists of:

a)A single axis PZT nanopositioner. The nanopositioner is composed of a preloaded piezo-stack actuator and a capacitive type position sensor. This process is a single-input single-output with inherent nonlinearity (hysteresis).

b)PXI hardware platform including (DAQ card and I/O FPGA),

c)NI LABVIEW software platform including (NI developer suit, control design and simulation module, and FPGA deployment module).

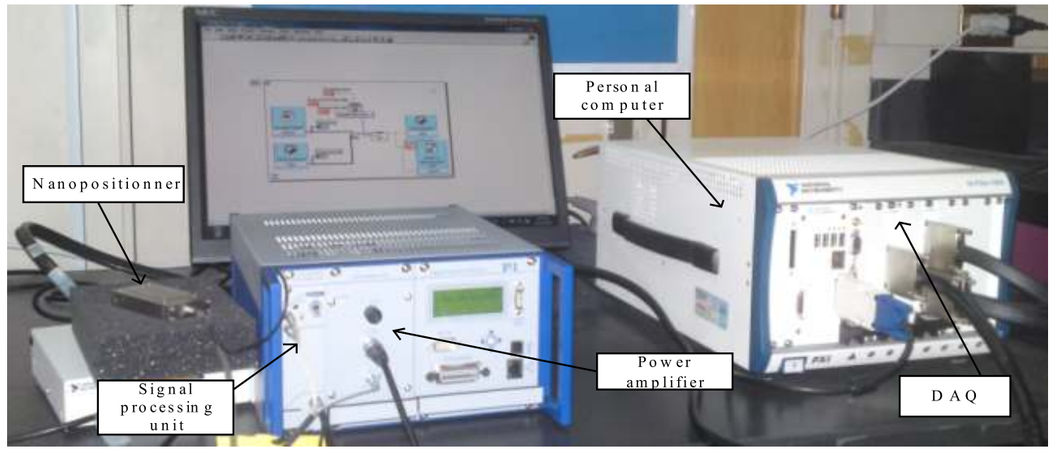
This setup permits to validate the developed PID and fuzzy control algorithms in an integrated simulation environment. It permits also to verify the simulation results in a real time closed loop using the DAQ card to control the target position of the PZT nanopositioner stage. Fuzzy controller has a superior performance as a non-linear controller to compensate the process nonlinearity than the classical PID controller. The FPGA card permits to investigate the system performance for embedded control applications as a final target.

Products Used:

NI LabVIEW with Control design and FPGA modules, NI PXI system with FPGA board, NI DAQ

Project Objectives:

- Create a research group in nanopositioning control and their applications
- Transfer the piezo technology in many applications (medical, industrial,… etc)
- Study the mechanical, geometrical, and electrical properties of piezo ceramic actuators
- Design a simple control mechanism for nanopositioning applications
- Design and implement a portable nanopositioner prototype (Embedded System)
- Apply the designed prototype in one of biomedical applications (e.g. automated injection system)



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College of Engineering King Saud University

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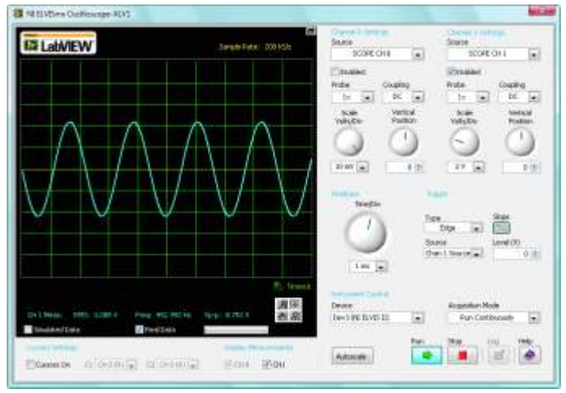
NI Education Platform for Communication fundamentals

Overview

The knowledge of communication fundamentals and concepts are essential in the electronics engineering domain. They form the basis of understanding the advanced concepts of RF and wireless measurements and communication as well as the various protocols and standards used in the industry today.

This platform is used to teach and understand the basics of communication systems. It consists of a trainer board used along with the NI ELVIS educational platform. With the trainer, students can build live communications systems in hardware by wiring together circuit blocks using patch cables. The trainer includes over 20 circuit blocks for fundamental communications operations and connectivity to NI ELVIS I/O.

After building a circuit with this module, students can apply the signal generation and measurement capability of NI LabVIEW and NI ELVIS platform to explore the system. Pre-written labs that engage students with a hands-on experience to teach communications concepts are included. Topics covered include analog and digital communications concepts such as AM, FM, DSB, SSB, PAM, PCM, PWM, speech, SNR, equation modeling, sampling, TDM, PCM, ASK, FSK, BPSK, QPSK, QAM, DSSS, noise generation and more.



Concepts covered

Basic Analog Communication

- Modulation - AM, FM, DSB, SSB, PM , PAM, TDM, PWM, QAM
- Superheterodyne
- Phase-Locked loops
- Speech in communications
- SNR concepts
- Modelling Math Equations

Basic Digital Communication

- Sampling
- Modulation – TDM, PCM, ASK, FSK, BPSK, QPSK, DPSK, GFSK, PCM-TDM
- Eye Patterns
- DSSS Spread spectrum
- Line coding
- Noise generation and noise in signals

Features

- Based on the NI ELVIS platform which integrates 12 most commonly used instruments – including oscilloscope, digital multimeter, function generator, bode analyzer, and more – in a compact form factor
- Soft front panels available on the PC to visualize the hardware system
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual
- Leverages industry grade systems so that students learn on systems which are currently used in the industry
- Data is presented in customizable visualizing formats and can be exported to tools such as Microsoft Excel or Adobe Acrobat if needed

Applicable Courses

- Analog Communication • Digital Communication
- RF&Wireless Communication

References

- Prince Mohammad University
- Bahrain Polytechnic

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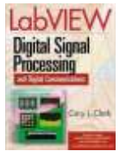

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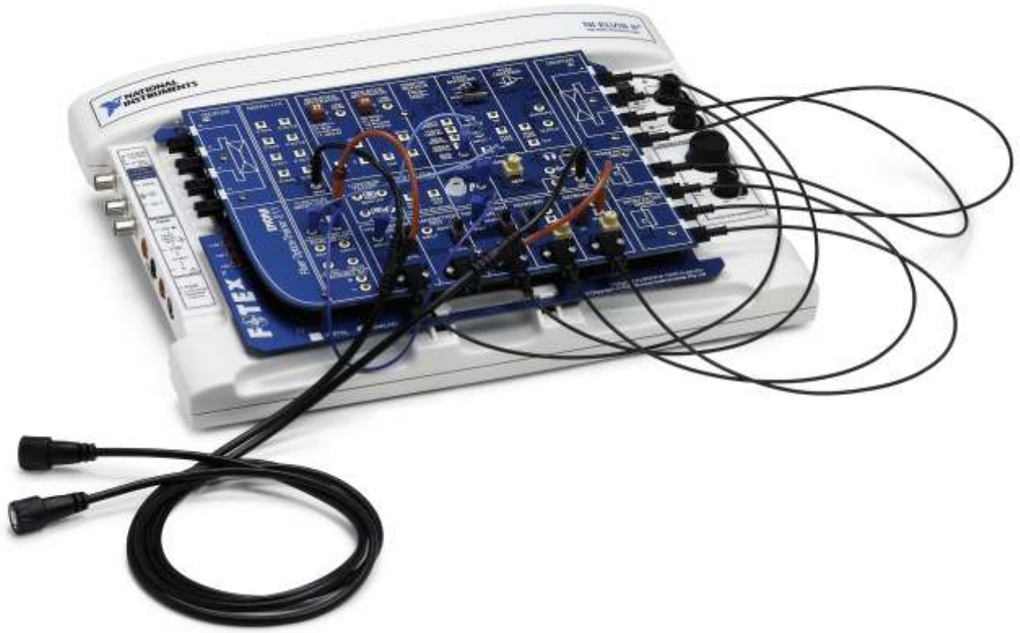
NI Education Platform for Fiber Optics



Overview

Fiber-optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fiber. First developed in the 1970s, fiber-optic communication systems have revolutionized the telecommunications industry and have played a major role in the advent of the information age. Because of its advantages over electrical transmission, optical fibers have largely replaced copper wire communications in core networks in the developed world.

The NI ELVIS platform uses different plug-in modules that enable a hands-on approach to teaching introductory concepts in electronics and telecommunication and uses a similar module for fiber-optic communications. With this system, students can build live communications systems in hardware and use fiber-optic connections to transmit the signals over fibers to examine and understand the properties of fiber-optic communication. It also includes over 20 circuit blocks for fundamental communications operations and connectivity to NI ELVIS I/O.

After building a circuit with the module, students can apply the signal generation and measurement capability of NI LabVIEW and NI ELVIS platform to explore the system. The kits include pre-written labs that engage students with a hands-on experience to teach communications concepts. Topics covered include PCM, sampling, TDMA, line coding and bit-clock regeneration, fiber optic transmission, optical signal filtering, splitting and combining, fiber optic-bidirectional communication, WDM, and more.

Concepts covered

- PCM - encoding
- PCM - decoding
- Sampling and Nyquist in PCM
- Time division multiple access (TDMA)
- Line coding and bit-cock regeneration
- Fiber optic transmission
- PCM-TDM 'T1' implementation
- Optical signal filtering, splitting & combining
- Fiber optic bi-directional communication
- Wave division multiplexing (WDM)
- Optical losses

Features

- Based on the NI ELVIS platform which integrates 12 most commonly used instruments – including oscilloscope, digital multimeter, function generator, bode analyzer, and more – in a compact form factor
- Uses the block diagram approach to interpret mathematical equations and theories and these can be directly implemented
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- Includes manuals and procedures for 13 complete experiments to teach various concepts in optical fiber communications and technology
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module
- Includes fiber optic cables to allow connection of various points for communication

Applicable Courses

- Digital Communication Systems
- Fibre optics
- Telecommunications theory

References

Prince Mohammad University

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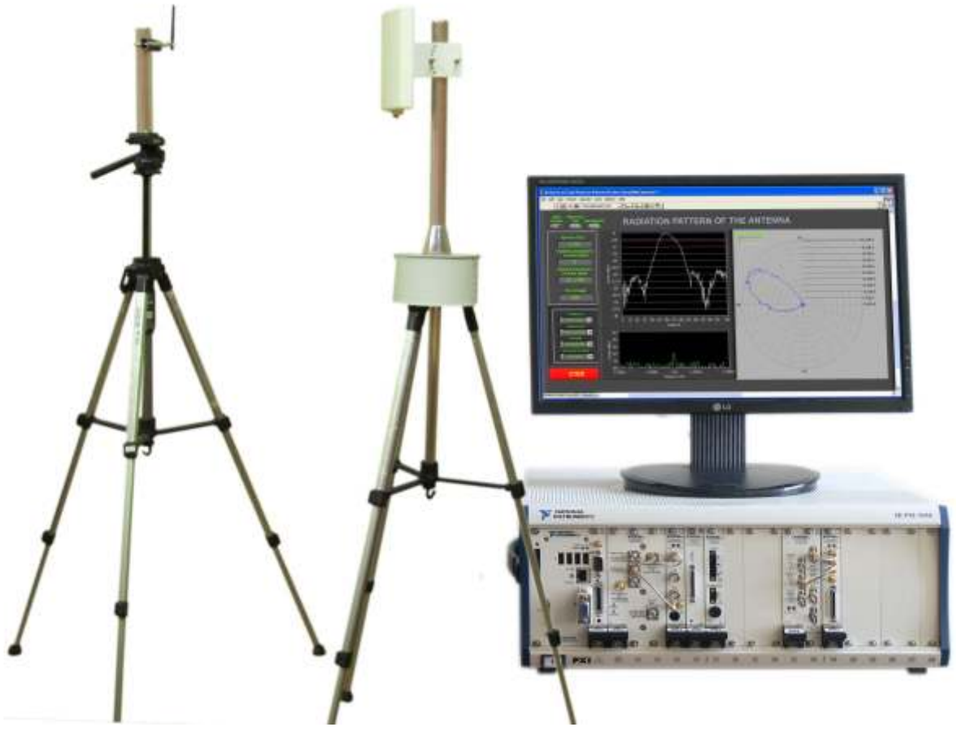
NI Education Platform for Antennas



Overview

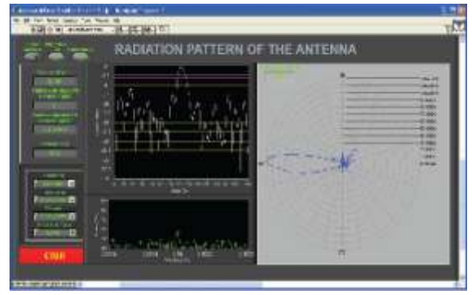
An antenna (or aerial) is a transducer that transmits or receives electromagnetic waves. In other words, antennas convert electromagnetic radiation into electric current, or vice versa. They are used to transmit and receive electromagnetic radiation of radio frequency, that is, radio waves, and are a necessary part of all radio equipment. Antennas are used in systems such as radio and television broadcasting, point-to-point radio communication, wireless LAN, cell phones, radar, and spacecraft communication.

The study of antennas and the associated concepts are a fundamental requirement for communication systems. Since every wireless communication system uses some form of antenna, it is important to understand the various antenna schemes, the benefits and drawbacks as well as key characteristics of each type. Further a study of radiation patterns enables one to understand propagation characteristics to help design and efficient communication system.

The laboratory facility is intended for hands-on study of radiation patterns of antennas. The facility is based on the NI RF PXI platform and uses software developed with NI LabVIEW graphical programming language. All hands-on experiments are implemented on the facility consisting of a turntable tripod used for mounting the antennas under test, a tripod for the auxiliary antenna, and a set of 7 antennas in the 2.4GHz range. Signal received by the antenna under test is fed to the RF spectrum analyzer for further processing.

The facility allows the students to measure the parameters of studied antennas by using the method of far field measurements.

Concepts covered



- Radiation patterns of dipole antennas - rod antenna.
- Radiation patterns of biquadratic antennas.
- Radiation patterns of YAGI antennas.
- Radiation patterns of horn antennas.
- Radiation patterns of parabolic antennas.
- Radiation patterns of cophasal antenna arrays.

Features

- Based on the open PXI platform with RF instruments
- Includes manuals and procedures for 6 complete experiments to understand the radiation patterns of different kinds of antennas
- Lab facility contains antennas along with a tripod mounted with a turntable to allow hands on learning
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module


Parabolic antenna


Cophasal antenna array


Horn antenna


Biquadratic antenna


Rod antenna (auxiliary)


YAGI antenna


Rod antenna (under test)

Applicable Courses

• Antenna and Wave theory • Communication Systems
• Telecommunications Theory • Communication Networks

References

Prince Mohammad University

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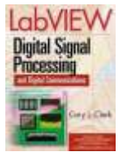

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Cory Clark,
McGraw Hil

Production Testing of RF and System-On-A-Chip Devices for Wireless Communication
Keith B. Schaub, Joe Kelly
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NI Education Platform for Advanced RF & Wireless Measurement

Overview

Instruction and research involving RF and wireless communications systems require a flexible platform for software design, hardware prototyping, and implementation. National Instruments RF tools deliver a high-performance platform for hands-on learning and pioneering research.

This platform is used to understand the advanced concepts of RF and wireless measurements, including transmitter and receiver characteristics, components of a communication system, spectral measurements , signal quality measurement on modulated and demodulated signals as well as impact of noise and other parameters on different parts of a communication system.

The NI Education Platform for Advanced RF & Wireless Measurement includes suggested hardware and software built on PXI, a rugged, PC-based platform with a front-loading CompactPCI form factor. Each lab station populates a PXI chassis with an RF signal generator (RFSG), an RF signal analyzer (RFSA), and a high-performance, embedded PC controller. The RFSG and RFSA form a transmitter/receiver pair for communications signals from DC to 6.6 GHz. Both the RFSG and RFSA are programmable with graphical applications built in NI LabVIEW software that execute on the embedded PC controller. Additional software includes toolkits that extend LabVIEW with RF/communications-specific functionality and tools for digital filter design and implementation.

Concepts covered

- Transmitter testing and characteristics
- Measuring Non-linear Distortion of a LF Signal
- Measuring Attenuation and Reflection in a Line
- Measuring a Pass Band
- Measuring Interference of Different Channels
- Measuring Error Rate During Data Transmission
- Receivers Testing
- Antennas Testing
- Sensitivity Measurements
- Spectral Characteristics Measurements
- Signal Modulation Quality Measurements
- Measuring Frequency and Non-linear Distortions
- Signal Demodulation Quality Measurements
- Measuring the Impact of Communication Channel on Signal Transmission Quality
- Analysis of Noise Impact on Signal Quality, Power Measurements

Features

- Open platform with industry standard hardware and software
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Single chassis with complete set of modular instruments – oscilloscopes, function generators, RF signal generators and analyser, vector network analyser (optional) , digital multimeter, RF multiplexers and switches and programmable power supplies, all of which are software programmable
- RF/communications-specific functionality and tools for digital filter design and implementation
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual
- Leverages industry grade systems so that students learn on systems which are currently used in the industry
- Data is presented in customizable visualizing formats and can be exported to tools such as Microsoft Excel or Adobe Acrobat if needed

Applicable Courses

• Analog Communication • Digital Communication
• Wireless Communication • Antennas

References

• King Abdul Aziz University • King Saud University • AIR University Pakistan • NED University Pakistan • Texas A&M Qatar

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Production Testing of RF and System-On-A-Chip Devices for Wireless Communication

Keith B. Schaub, Joe Kelly

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Communication Labs for the ECE department at Dogus University

Abstract:

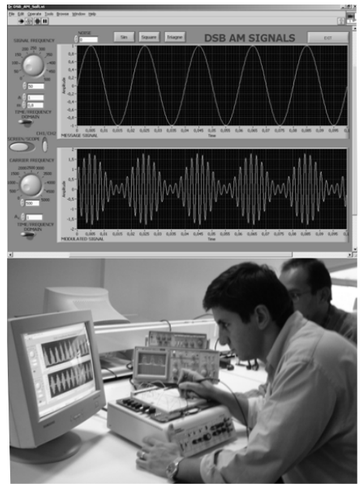
A set of virtual tools for analog and digital communication labs is designed and introduced. The NI-ELVIS set and NI LabVIEW are used for this purpose. The designed double-side band, single-side band, carrier-suppressed double-side band amplitude modulation and demodulation tools may be used in basic undergraduate communication lectures. Moreover, these virtual tools may be used in distance education over internet via remote panels which basically relies on the simulation of engineering courses to illustrate the physical phenomena.

Products Used:

NI ELVIS with Communication trainer modules, NI LabVIEW

Details: The ECE Department of Doğuş University in Istanbul has started to use NI-ELVIS in Analoğ and Diğital Communication lectures, ECE 311 and ECE 312, respectively since 2004. The Analoğ Communication Lab (in ECE 311) contains the experiments and VIs for

- The Fourier Transform
- Double SideBand (DSB) AM Signals
- Double Sideband (DSB) Amplitude
- DSB Suppressed Carrier (DSBSC) AM Signals
- Single SideBand (SSB) AM Signals
- Envelopes and Envelope Recovery (Demod. of DSB)
- The Angle Modulation (FM & PM).



Similarly, experiments and VIs of the Digital Communication Lab (in ECE 312) are:

- Sampling
- Time Division Multiplexing
- Pulse Code Modulation
- Amplitude Shift Keying
- Frequency Shift Keying
- Binary Phase Shift Keying
- Delta Modulation.

A general view of the front panel that are designed for the communication labs is as shown in the figure. This front panel belongs to the double-side-band AM. This example belongs to a 50 Hz single tone message signal modulating a 500 Hz carrier signal with the modulation depth of m=0.8. The window on top presents the graph of message signal vs. time, while the one at bottom belongs to the AM signal vs. time plot. All the parameters of these two signals can be specified and altered with the knobs and buttons reserved at the left. A sinusoidal message signal modulates the amplitude of a carrier signal. The frequency and the amplitude of the message signal and of the carrier signal can be chosen as desired using numerical controls and knobs. The message signal may be sinusoidal, rectangular, or triangular. Noise can also be added to the message signal. Finally, the user can also display the signals in frequency domain by changing the position of a toggle switch as shown in the figure. A photo of a complete student lab set is shown in the figure with the LabView installed PC, NI-ELVIS set, and an oscilloscope.

Conclusion: Novel virtual tools (VT) are designed for the ECE communication labs at Doğuş University of Istanbul. These VTs certainly lower the cost of the lab establishment while improviŋg teachiŋg/learniŋg capability. Since eŋgineeriŋg should be based on practice, the hybrid usaŋe of hardware and software via NI ELVIS product bundle is an optimum solution. It should be noted that these approaches will also form the fundamentals of distance education.

Author | Levent Sevgi, Çağatay Ulu ışık ,Doğuş University, Electronics and Communication Engineering Department,Istanbul, Turkey

RF, Radar & ECM Postgraduate Research and Development Lab at Institute of Avionics & Aeronautics

Abstract:

Fhe aim of this lab is provide reconfigurable research platforms for software defined radios, frequency hopping radios and systems, wireless Adhoc networks, HF, UHF, VHF spectrum monitoring and selective jamming including the concepts of OFDM implementation and testing services. RF, Radar and ECM lab is equipped to support research in the following areas:

1. Software Defined Radios
2. Hopping Radios Analysis and Testing
3. Self Protection Friend Aware Jammers
4. Wireless Adhoc Networks
5. Radar Signal Processing
6. HF/UHF/VHF Smart Spectral Monitoring
7. RF Testing & Diagnostics

Products Used: NI PXI with NI RFSA and RFSG and Modular Instruments

Details:

The following projects have been undertaken at the R&D facility:

a) Agile Frequency Monitoring - Next Generation spectrum denial solutions face the challenge of real-time following the Frequencies of Communication system to ensure that only desired frequencies are affected

b) Software Defined Radio - The research is in progress of developing next generation radio based on the LabVIEW FPGA technology to develop a Generic SDR framework that is flexible, modular, reconfigurable and reusable

c) Automated Test System for Radios and RF components - Testing legacy RF systems with little design information is a challenging task. RF testing group is involved in creating test applications for such legacy systems.

d) Generic Radar Signal Processing and Generation - Many legacy radars can be upgraded by changing the hardware in the Receiving path giving them the new lease of life. Radar group is developing a Radar Signal Processing Unit using NI COTS RF Technology.

Author | Dr. Nadeem Lehrasab | Department of Avionics Engineering, IAA, Air University, E-9 Complex, Islamabad, PAKISTAN .

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NI Education Platform for Strength of Materials

Overview

Strength of materials is a subject which deals with loads, deformations and the forces acting on the material. A load applied to a mechanical member will induce internal forces within the member called stresses. Those stresses acting on the material cause deformations of the material. Deformation of the material is called strain, while the intensity of the internal forces are called stress.

The hardware setup consists of a bench-mounted trainer, which consists of a loading station and a set of mechanical objects. Any tensions and deformations appearing in the studied objects are measured with surface-mount strain gauge probes. In the process of deformation, various mechanical parameters of experimental objects made of different materials and shapes can be studied.

Data acquisition from the mounted strain gauges is achieved by means of the National Instruments Compact RIO based Industrial Controller, which consists of a reconfigurable FPGA running the process control algorithm and I/O modules.

The Compact RIO system is programmed by means of a graphical user interface, based on National Instruments LabVIEW. A whole range of analysis functions are available to further analyze the data obtained and understand the underlying principles of the entire process along with computing various parameters related to strengths of the different materials. The software is menu-oriented and allows the student to choose from 16 hands-on operations. Corresponding sections of the manual are included in lab software so students can review theoretical concepts without interrupting practical work on the lab. Experimental results of the lab may be exported and saved in a variety of formats.

Concepts covered

- Modulus of Elongation and Poisson Ratio
- Stress in a bar under eccentric tension
- Modulus of Shearing and Strain-Stress distribution in a bar under torsion
- Strain-Stress analysis in a plane frame, practical test of reciprocity theorem
- Stress distribution in concentration area and in a distant zone; determination of Concentration Coefficient
- Shear in a bending beam and bearing reaction in a statically indeterminate beam
- Stress and shear in a beam under oblique bending
- Position of the shear center; experimental study of the direct sectoral stress distribution law under constrained torsion
- Critical load for a compressed bar (Southwell method)
- Experimental study of Hooke's law and the law of linear distribution of direct stress in a beam cross section during bending
- Strain-stress distribution in a cantilever bar and disks made of different materials (steel, alloys).
- Zero-torque and torque strain-stress distribution in a cylindrical shell

Features

- NI Compact RIO reconfigurable industrial controller for data acquisition and actuator control with inbuilt FPGA used to store and execute control algorithms and Real-Time OS for data acquisition and system control.
- Open platform with industry standard hardware and software
- Includes manuals and procedures for 16 complete experiments to understand the radiation patterns of different kinds of antennas
- Bench mountable loading platform with a set of mechanical objects and in-built strain gauges
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual
- Leverages industry grade systems so that students learn on systems which are currently used in the industry
- Data is presented in customizable visualizing formats and can be exported to tools such as Microsoft Excel or Adobe Acrobat if needed

Applicable Courses

- Civil Engineering
- Structural Engineering
- Strength of Materials
- Material science

References

- Prince Mohammad University
- Bahrain Polytechnic

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NI Education Platform for Vibration & Machine Diagnostics

Overview

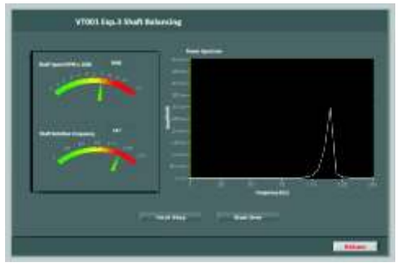
Vibration refers to mechanical oscillations about an equilibrium point. The purpose of this laboratory facility is to provide students hands-on study of Vibration Measurements and concepts and Machine Diagnostics. It is based on the NI PXI platform or the NI Compact RIO platform with software and experiments developed using the graphical programming language NI LabVIEW.

The plant consists of a rotary device with loads, imperfection imitators, and sensors; a variable frequency driver is included for motor speed control. Students can accelerate and decelerate the motor, balance the imitators, align the axes, study the effects of various common manufacturing and operational defects and misalignments. They will also master sensor data processing through the application of mathematical filters and algorithms. Results can be viewed and analyzed in LabVIEW itself, or can be exported to software such as Microsoft Excel for further analysis and reporting.

Data acquisition is performed using either the PXI or the CompactRIO platforms. For both, a range of Dynamic Signal Acquisition (DSA) modules are available, which have high dynamic range and accuracy and are ideally suited for vibration sensors. The modules possess in-built signal conditioning for ICP/IEPE based sensors. High speed modules with both DC and AC coupling options are available

The software is based on the highly intuitive graphical programming language LabVIEW. Pre-written code for different experiments is included as part of the course material, however students have the flexibility to write custom code and design custom experiments with the hardware available to them. Also included is the LabVIEW Sound & Vibration Measurement Suite which has a complete set of features, algorithms and APIs tuned to the Measurement of vibration signals. These include analysis functions such as Transforms, Order tracking etc, and visualizations such as waterfall plots and 3D displays

Concepts covered



- Vibration fundamentals
- Free damped and undamped vibrations
- Vibrations of an induction motor and rotary device
- Vibrations caused by manufacturing defects (misalignment and skew of axis)
- Vibrations caused by bearing bore defects
- Dependence of vibration characteristics on mass of imbalance, position of imbalance, mounting and distance between supports
- Imitation of operating load and its influence on vibration
- Effect of bearing and supports

Optional Add-On - Study of Balanced/Unbalance rotation

An add-on option is available to study balancing of a rotary object by means of an additional trainer. This trainer consists of two fans one of which is designed to be unbalanced by breaking off one of the blades. The trainer can be used to control the speed of each fan and the integrated vibration sensors pick-up the signals and transfer these to the data-acquisition system for analysis

Features

- Open platform with industry standard hardware and software
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- PC based trainers with integrated sensors, motor and a rotating shaft which can be fully controlled. Measurement of vibration at several points is possible under conditions which can be varied via software on the PC
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Versatile data acquisition system, with plug and play modules, which can be configured to build multiple measurement systems
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual
- Leverages industry grade systems so that students learn on systems which are currently used in the industry
- Data is presented in customizable visualizing formats and can be exported to tools such as Microsoft Excel or Adobe Acrobat

Applicable Courses

- Mechanical Engineering
- Structural engineering
- Machine design
- Machine and system diagnostics

References

- Prince Mohammad University
- Bahrain Polytechnic
- King Fahd Univeristy of Petroleum & Minerals

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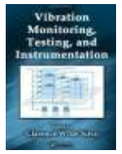

Vibration Monitoring, Testing and Instrumentation
Clarence W. de Silva
CRC Press

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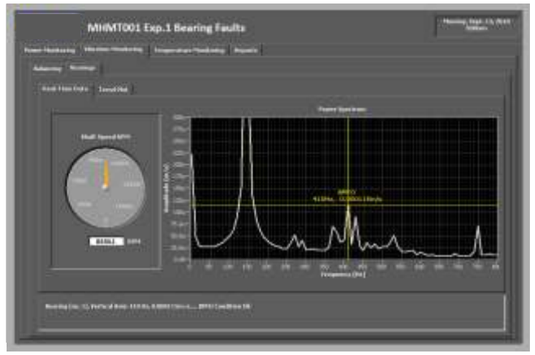
NI Education Platform for Machine Condition Monitoring

Overview



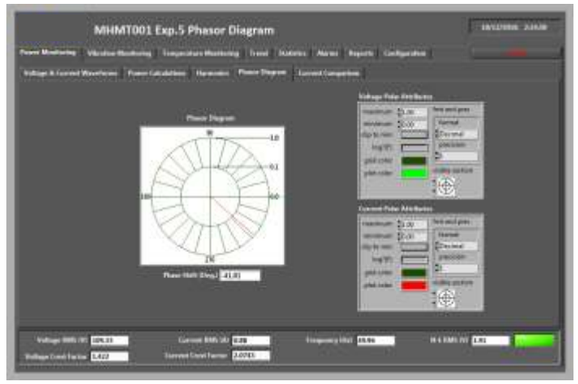
Machine condition monitoring is the process of monitoring a parameter of condition in machinery, such that a significant change is indicative of a developing failure. It is a major component of predictive maintenance. The use of conditional monitoring allows maintenance to be scheduled, or other actions to be taken to avoid the consequences of failure, before the failure occurs.

The NI Educational Platform for Machine Condition Monitoring is used to demonstrate Intelligent Maintenance concepts. Through a series of experiments and investigations that study mechanical and electrical components of a machine, the student is introduced to machine health monitoring main parameters; vibration, power and temperature. Learning to monitor these parameters helps the student better understand machine and components' degradation that lead to failure.

Students will learn what vibration parameters to monitor for detecting motor balance and bearings status. They will also be introduced to power quality concepts that contribute to machine health including voltage and current waveforms, harmonics, frequency, active and reactive power, power factor and so on.

The platform includes a detailed manual with experiments to understand the various concepts of condition monitoring with software based on the highly intuitive graphical programming language NI LabVIEW and a hardware based on National Instruments CompactRIO or PXI platforms. Pre-written code for different experiments is included as part of the course material, however students have the flexibility to write custom code and design custom experiments with the hardware available to them.

Concepts covered



- Introduction to Signal Processing
- Vibrations Fundamentals
- Shaft Balancing & Bearing Faults
- Power Fundamentals
- Voltage & Current Waveforms
- Harmonics
- Phasor Diagram
- Power Calculation
- Temperature Monitoring

Features

- Open platform with industry standard hardware and software
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- Computer based Machine Health Monitoring trainer used to teach vibration, power and temperature monitoring in rotary motors
- Comprises all required sensors to measure vibration, temperature and power parameters including accelerometers, speed sensor, high speed motor, variable speed drive, faulty bearing and unbalancing screws
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Versatile data acquisition system, with plug and play modules, which can be configured to build multiple measurement systems
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual
- Leverages industry grade systems so that students learn on systems which are currently used in the industry
- Data is presented in customizable visualizing formats and can be exported to tools such as Microsoft Excel or Adobe Acrobat

Applicable Courses

- Mechanical Engineering
- Machine design
- Machine and system diagnostics
- Automotive engineering

References

- Prince Mohammad University
- King Fahd Univeristy of Petroleum & Minerals
- Bahrain Polytechnic

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Intelligent Control Systems with LabVIEW

Pedro Ponce-Cruz, Fernando
D. Ramírez-Figueroa

Springer

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PC Based Sound & Vibration Measurements for Education & Research

Abstract:

Setting up a laboratory for Sound & Vibration experiments catering to both education and research. For teaching, each course attendant should be able to acquire measurement data, perform post-processing and calculations thereby requiring separate stations for each student.

The system must also be open and flexible to allow for research related studies and experiments.

Challenges:

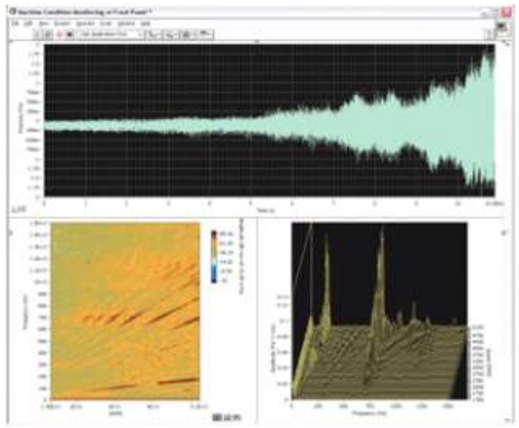
Huge number of students, expensive equipment, limited time for the lab exercise.

Products Used:

NI LabVIEW, NI Sound & Vibration Toolkit, NI PXI system with Dynamic Signal Acquisition hardware

Details:

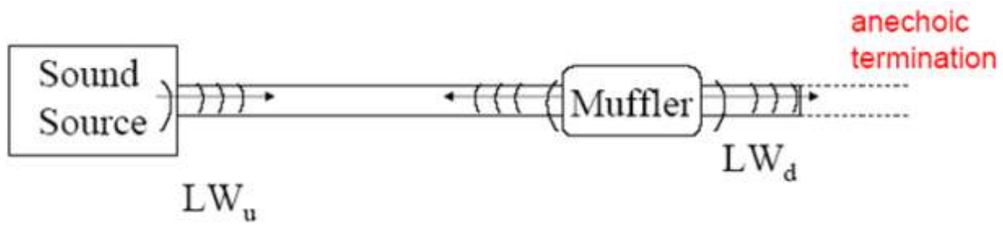
Networked system using PC based sound and vibration data acquisition hardware along with external sensors and signal conditioning. A switching matrix was used to route signals from all the sensors to individual PCs. The lab caters for upto 26 students performing experiments simultaneously.



From a research perspective, the NI Sound & Vibration system and the use of NI LabVIEW with the Sound and Vibration Toolkit enabled complex research studies and experiments.

An example for a research project completed was a study on Muffler Transmission Loss which required to measure difference between incident sound power levels and transmitted sound power level when tailpipe has anechoic termination

Since Anechoic Termination is impossible to achieve a Two-Source Technique to eliminate reflections effects and the method followed was Calibrate – Measure 1 – Measure 2 – Save – Post-process using the NI PXI system as the measurement system and the architecture below



Author | Tamer Elnady, ASU Sound and Vibration Lab, Faculty of Engineering, Ain Shmas University

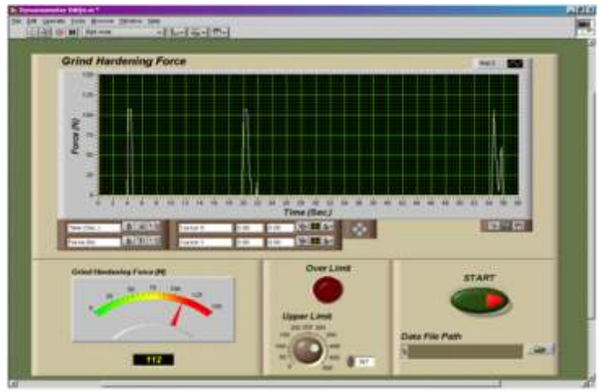
Data Acquisition System for Force Measurement during Grind-Hardening Process

Abstract:

Developing a complete Data Acquisition System for On-Line monitoring of Grind-Hardening process using available Kistler dynamo-meter and developing the data acquisition system using National Instruments data acquisition hardware and the graphical programming language NI LabVIEW

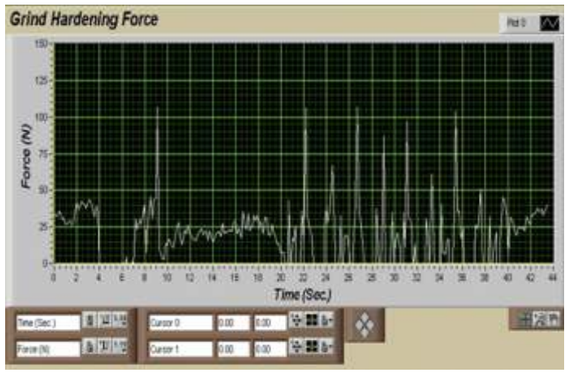
Products Used: NI LabVIEW, NI Data Acquisition

Details: The whole setup was built using a single PC to control and monitor the process using NI LabVIEW software. The system is made of Kistler dynamometer connected to a charge amplifier which is connected to a screw terminal, the output signal to logged using an NI data acquisition (DAQ) card. The signals obtained from the dynamometer are converted into voltage, and then they are transferred to the charge amplifier efficiently using shielded wiring, thus secure data transfer between the DAQ board and the PC is obtained; then the data is automatically saved for further analysis.



Using this system data can be logged continuously and any collected data can be recalled. Using this system high sampling rates, instantaneous data logging and monitoring with no delay can be achieved with the added ability to be adapted to any other dynamometers after the calibration stage.

The tangential force change represented by the dynamometer; over which the workpiece is mounted, during the Grind- Hardening process is shown in the figure.



Conclusion:

We developed stand-alone dynamometer control system for Grind-Hardening process control and monitoring. We achieved high programming efficiency, high performance and cost saving using LabVIEW 6.1 software and National Instruments DAQ hardware to build the Grind-Hardening control system. It is now possible to monitor, control and log data from such dynamometer using any ordinary PC.

Author | Prof. Dr. M.Al-Makky and Eng. M.Eltoukhy Faculty of Engineering, Alexandria University, Egypt.

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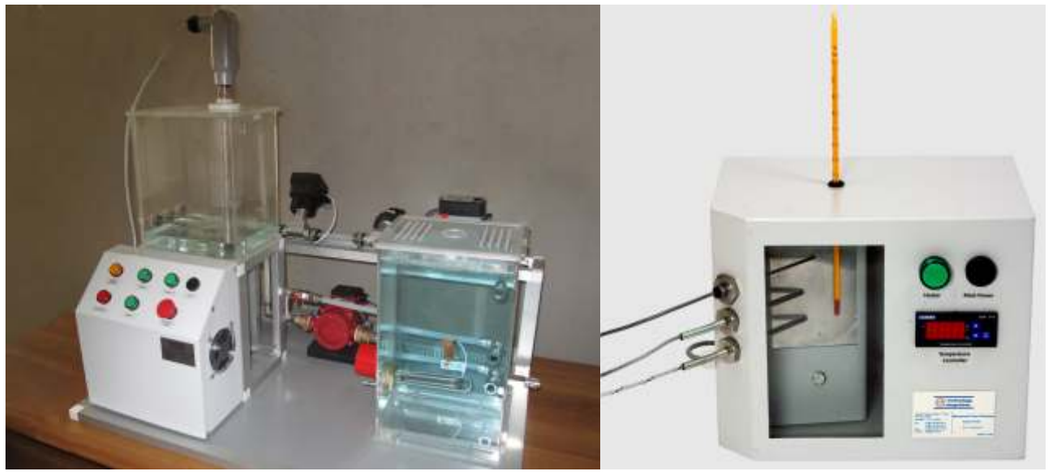
NI Education Platform for Measurements

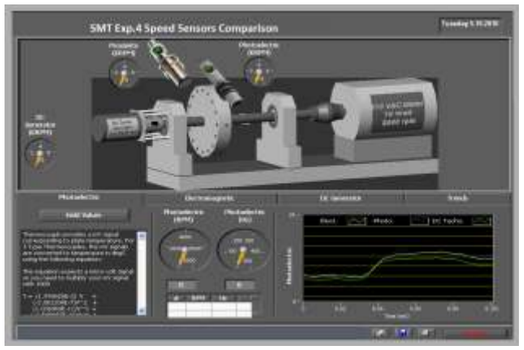


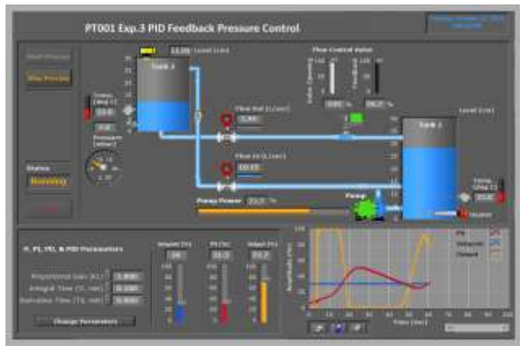
Overview

Measurement, the process of estimating or determining that magnitude of a quantity is a fundamental component of engineering science. The study of measurements, involves various sensors and transducers, which allow us to measure different physical parameters and study their characteristics.

National Instruments provides an intuitive platform that can connect to thousands of sensors and instruments in order to acquire, analyze and process signals and present results graphically. The NI Education platform for Measurements is designed to give the engineering student hands-on experience with measurement equipment and data acquisition software and hardware that scientists and engineers may encounter in their respective careers. Upon completion of the lab, it is expected that the engineering student will demonstrate fundamental knowledge and operation of engineering instruments and transducers and associated signal conditioning units as well as knowledge on principle of data acquisition and measurement.

The NI Education platform for Measurements comprises of trainers with integrated sensors for parameters such as temperature, pressure, level and flow, speed, force and strain. The measurement system comprises of National Instruments Signal Conditioning and Data Acquisition hardware, and experiments built in software using the graphical programming platform NI LabVIEW.





Concepts covered

- Measurement systems, basic methods of measurement, units and standards, errors in measurements, uncertainties, modular signal conditioning and Virtual Instrumentation
- Interfacing to PC hardware and DAQ boards and interface using instrument I/O (GPIB), data acquisition and different formats of data transfer over the computer bus such as buffered and continuous transfers
- Fundamental concepts of analog to digital converters, analog output and timers/counter signals, conditioning of different types of signals, sampling rates and Nyquist criterion
- Signal concepts such as noise-margin and filtering of signals, signal analysis, static(Time Domain) analysis, thresholding and alarming, trending, dynamic(Frequency Domain) analysis, power spectrum, octave analyses, transducer characteristics, linearity, calibration, compensation, and working range(Signal Amplitudes)
- Response time(Bandwidth), passive and active transducers and digital transducers
- Characteristics and response of temperature sensors such as thermocouple, RTDs, Thermistors and Thermometers as well as Temperature controllers, heaters and fans
- Flow meter characteristics and comparison – Venturi, Paddle Wheel and Magnetic
- Pressure and level measurement, Ultrasonic, Capacitive, Piezoresistive sensors, their working and characteristics
- Strains gauges, Load cells and weights – working of these sensors and making measurements
- Speed measurement using Tachometers, Proximity probes and electromagnetic sensors for rotating shafts
- Photo-Electric Sensors
- Potentiometers: Characteristics and Loading Effects
- LVDT: Construction, Working Principle, Performance Characteristics, Applications
- Microphones: Construction, Working Principle, Performance Characteristics and Variations
- Accelerometers: Working Principle, Characteristics and Applications, Current Excitation
- Humidity Sensors: Hot Wire Anemometer, Constant-Current, Constant-Temperature Type

Features

- Versatile data acquisition system, with plug and play modules, which can be configured to build multiple measurement systems
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- PC based trainers with integrated sensors for measurement of various physical parameters, trainer can be controller via the PC and all data can be stored and analysed
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- Integrates concepts from Signal theory, data acquisition and instrumentation
- Leverages industry grade systems so that students learn on systems which are currently used in the industry

Applicable Courses

• Transducers and sensors • Instrumentation engineering
• Data Acquisition systems • Signal theory • Instrument control

References

• PMU • KFUPM • KSU
• Canadian University of Dubai
• Ibra College Oman
• NUST SMME Pakistan

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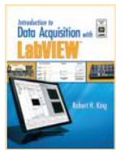
Theory and Design for Mechanical Measurements,

Richard Figliola and Donald Beasley

Wiley



Introduction to Data Acquisition with LabVIEW,

Robert H. King,

McGraw-Hill

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NI Education Platform for Mechatronics Sensors

Overview

The NI Education Platform for Mechatronic Sensors is a set of add-on trainer modules, used with the NI Educational Laboratory Virtual Instrumentation Suite (NI ELVIS), which provide the components you need to study and understand the applications and working of various sensors used in mechatronics.

The module help steps the student through the physical properties of most sensors used today and the techniques and limitations of their applications. It features four digital sensors: push button, single-pole double-throw (SPDT) micro-switch; transmissive optical switch; reflective optical switch; and magnetic Hall effect switch. It also features six analog sensors: potentiometer, optical analog distance, magnetic analog field, pressure, temperature, and piezo film.

Concepts covered

- Benefits and drawbacks of certain sensors
- Sensor behavior
- Calibration
- Using sensors to identify natural frequency of material
- Need for debounce in switches and buttons
- Understanding how encoders work

Features

- Includes manuals and procedures for complete experiments to teach various concepts in mechatronic sensors Based on the NI ELVIS platform which integrates 12 most commonly used instruments – including oscilloscope, digital multimeter, function generator, bode analyzer, and more – in a compact form factor
- Includes more than 10 different types of sensors/switches: Strain gage, Piezo film sensor, Rotary potentiometer, Pressure sensor, Thermistor sensor, Sonar, infrared, optical, and magnetic field range sensors, Micro switch, push button, and optical switch , two digital output LEDs and an Encoder
- Fully customizable experiments, design your own experiments and create custom problems
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module
- Systems are compact and easy to store with a plug-and-play design to allow quick and easy setup

Applicable Courses

- Control systems
- Mechatronics
- Instrumentation & Sensors

References

Dhofar University Oman

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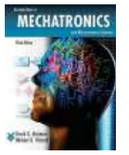
Applied Mechatronics

Smaili, F. Mrad

Oxford University Press



Introduction to Mechatronics and Measurement Systems

David G. Alciatre, Michael B. Histand

McGraw-Hill

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NI Education Platform for Biomedical Instrumentation and Engineering

Overview

Biomedical engineering is a highly interdisciplinary subject that features diverse subfields and groups and is influenced by a variety of engineering and medical fields. For many biomedical engineering majors, the first introduction to making measurements from the body is through their bioinstrumentation course. In this course, students are often exposed to the design, simulation, and prototyping of components found in medical devices such as an instrumentation amplifier or interfacing with sensors.

The NI Education Platform for Biomedical Instrumentation and Engineering comprises a series of experiments conducted using NI Multisim in conjunction with the NI Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) to first understand basic bio-instrumentation concepts.

This is followed by a set of experiments using a Biomedical trainer module for the NI ELVIS which provide the hardware components you need to study and understand the applications and concepts in biomedical engineering. Students can learn how to control a servo from the contraction of muscles using the principles of electromyography (EMG).

Concepts covered

- Basics of Biomedical Instrumentation
- Sensor principles
- Instrumentation amplifiers, filters, signal conditioning and data acquisition
- Biopotential Electrode and Amplifier
- Electrocardiograph
- Blood flow and Pressure Measurement
- Electrical safety
- Electromyogram
- Developing task-based servo control from processed electromyogram

Features

- Includes manuals and procedures for complete experiments to teach various concepts in biomedical instrumentation and engineering using the trainers and software
- Based on the NI ELVIS platform which integrates 12 most commonly used instruments – including oscilloscope, digital multimeter, function generator, bode analyzer, and more – in a compact form factor
- Fully customizable experiments, design your own experiments and create custom problems
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Electromyograph with opto-isolated electrode and a grounding strap which runs on two AA batteries
- Board uses a pulse-width controlled metal gear servo and includes signal conditioning circuit and PWM
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module
- Systems are compact and easy to store with a plug-and-play design to allow quick and easy setup

Applicable Courses

• Bio-instrumentation • Medical electronics
• Biomedical Engineering • Instrumentation & Sensors

References

King Saud University

View suggested textbooks at ni.com/textbooks

Virtual Bio-Instrumentation - Biomedical, Clinical, and Healthcare Applications in LabVIEW

Eric Rosow

Medical Instrumentation, Application, and Design Third edition

John G. Webster

Wiley

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NI Education Platform for Signals & Systems

Overview

The NI Educational Platform for Signals and Systems based on the National Instruments Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) makes it possible for students to experience at first hand the interaction between the theory and mathematics of the digital signal processing, circuit analysis and signals and systems textbooks, with the real world of hardware and of signals in wires and waves.

The accompanying 16 experiment lab manual covers introductory level experiments, designed to provide hands on exercises covering most of the key concepts and challenges in Signal Processing and Signals & Systems courses

The platform is designed to provide a practical "hands-on", experiential, lab-based component to the theoretical work presented in lectures on the topics typically covered in introductory signals courses for engineering students. With an understanding of differential equations, algebra of complex numbers and basic systems theory, engineering students in general can reinforce their understanding of these important foundational principles through practical experimentation. This provides a foundation for further study of communications, control, and systems engineering.

Concepts covered

- System modeling and characterization
- Time and frequency domain representations and analysis
- Convolution
- Sinusoids and complex exponentials in LTI systems
- Transfer functions and system responses
- Sampling and aliasing
- Using poles and zeros to interpret and design system responses
- Conditions for stability
- Spectrum analysis and applications
- Discrete-time signals and z-transforms
- Filter design and applications - continuous and discrete-time
- Analog-digital interfacing

Features

- Includes manuals and procedures for complete experiments to teach 16 complete experiments on various concepts in signals and systems
- Based on the NI ELVIS platform which integrates 12 most commonly used instruments – including oscilloscope, digital multimeter, function generator, bode analyzer, and more – in a compact form factor
- The board includes all of the functional blocks - integrators, sample-and-hold, unit delays and supporting blocks - required for all experiments, as well as access to powerful instruments from NI ELVIS
- Fully customizable experiments, design your own experiments and create custom problems
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module
- Systems are compact and easy to store with a plug-and-play design to allow quick and easy setup

Applicable Courses

- Signals & Systems
- Signal Processing
- Communication systems

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GSM RF Equipment Testing and Performance Analysis

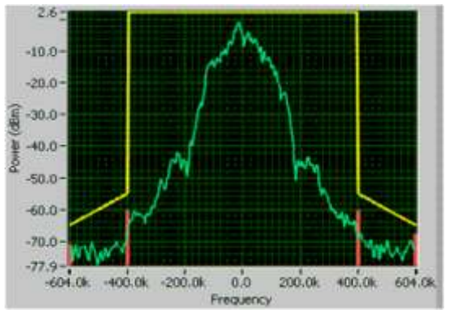
Abstract:

Four Radio Frequency (RF) measurements used to evaluate fundamental performance parameters of Global System for Mobile Communications (GSM) equipment are presented. The relevant theory for each measurement is described, and then the algorithms associated with it. These algorithms are implemented using LabVIEW in a GSM Measurement Toolkit (GMT). GMT is developed for National Instruments (NI) to be used with PXI-5660 RF Signal Analyzer (RFSA) to test RF equipment. Using this toolkit, a Base Transceiver Station (BTS) downlink signal and a Mobile Station (MS) uplink signal are tested to ensure their conformance to 3rd Generation Partnership Project (3GPP) standards.

Products Used: NI LabVIEW, NI PXI system with NI RF Vector Signal Analyser

Details: GSM is the most widely deployed mobile system with more than half a billion users spanning the globe. Measurements are indispensable for both GSM manufacturers and operators who are very concerned about the cost of test equipment. These measurements are used in quality control, calibration, and maintenance of both mobile and base stations. The process of testing consumes a lot of resources in terms of time and budget. NI's virtual instrumentation technology promises a great reduction in test costs and enables the customer to administer the test setup and apply customized configurations. The four measurements, described throughout this work and included in the GMT, are adjacent channel power, modulation accuracy, mean transmitted RF carrier power, and transmitted RF carrier power versus time. For each measurement, we introduce its theory and illustrate its implementation in LabVIEW. The NI PXI- 5660 RFSA and GMT are used to test a BTS downlink signal and an MS uplink signal.

The four measurements – Adjacent Channerl Power, Modulation Accuracy, Mean Transmitted RF Carrier Power and Transmitted RF Carrier Power versus Time are implemented using LabVIEW, with Spectral Measurements Toolset and Modulation Toolkit, and included in the GMT. LabVIEW, a data-flow programming platform, provides a great graphical development environment for signal acquisition, measurement analysis, and data presentation. It delivers the flexibility of a programming language and avoids the complexity of traditional development tools. The basic unit in LabVIEW is the VI. The VI is an instrument driver divided into a front panel and a block diagram. The front panel forms the Graphical User Interface (GUI) of the driver while the block diagram forms graphical code which is compiled into machine code. Our GMT is designed for use along with NI PXI-5660 RFSA for GSM RF equipment testing. All its measurements are integrated in one VI.



Conclusion:

The importance of this toolkit lies in the fact that it offers the same functions provided by highly expensive GSM testing equipment, which are widely used by vendors and operators. Finally, we conducted realtime RF tests on a BTS and an MS.

Author | Ahmad H. Fares, Ali M. Khachan, and Ahmad M. Bakri Kasbah Department of Electrical and Computer Engineering American University of Beirut Beirut - Lebanon

Design & development of Bio-potential Data Acquisition System

Abstract:

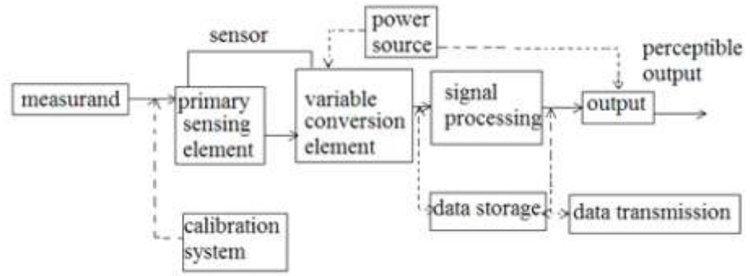
Design and development of a system to improve the quality of applied biomedical engineering education by using NI products as educational tools for quantitative physiological laboratory experiments. To reduce laboratory equipment overhead cost, by providing a low-cost bio-potential signal data acquisition unit and to reduce the time for experimental setup and calibration during routine laboratory sessions.

Products Used:

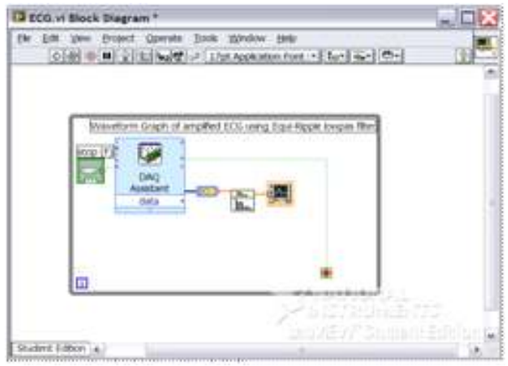
NI LabVIEW and NI USB data acquisition

Details:

A low-cost multi-purpose DAQ system was developed to acquire the following biopotentials amongst others: electrocardiograms (ECG), electromyograms (EMG), electroencephalograms (EEG), electrooculograms (EOG), and electrogastrograms (EGG). The biomedical instrumentation design followed the general scheme employed in conventional biomedical devices. The figure, depicts a simplified block diagram of a biomedical instrument.



Much of the above-mentioned biopotential signals are in the micro/millivolt range with varying frequency responses ranging from dc to a few kilo Hertz. Accordingly, a four-channel bipolar front end circuitry, consisting of a (x1, x5, x10) preamplifiers, (LPF, HPF, BPF) active/passive filters, and (x100, x1000) instrumentation amplifiers, was developed to precondition the raw biopotential measurands. In most applications, biosignals were picked up using disposable Ag/AgCl electrodes with one centimeter sensing diameter. The front end circuitry was connected to an NI USB DAQ unit programmed under NI LabVIEW™ Ver. 8.0 to control data acquisition, perform signal processing, and store the acquired data in real time. The sampling rate was adjusted in accordance with the type of acquired biopotential using the Nyquist criterion (sampling theorem). Calibration was performed intrinsically by the NI unit. The computer used in conjunction with the developed biopotential instrumentation was a Toshiba Satellite M35-S 456 notebook. The notebook operated on a Microsoft Windows XP 2002 platform. The Figure illustrates a sample block diagram for an ECG data acquisition application using LabVIEW™.



Author | Toufic F. Hamdan, Ziad O. Abu-Faraj, Ph.D., Department of Biomedical Engineering American University of Science and Technology (AUST), Beirut, Lebanon.

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NI Education Platform for Microcontrollers

Overview

Designed to provide an integrated suite to teach design and test of microcontroller systems, the NI Educational platform for Microcontrollers is based on the NI Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) system along with an add-on board based on the Freescale HCS12 microcontroller. This teaching platform features all the components to provide a hands-on approach to microcontroller programming and test.

The NI ELVIS II with the Freescale Microcontroller (MCU SLK) plug-in board allows students to rapidly design and prototype electronic systems around a variety of 8-, 16- and 32-bit computing platforms from Freescale Semiconductor. NI ELVIS II, with its programmable I/O and tight integration with NI LabVIEW, makes it easy to develop complex embedded applications. With labs available for easy download and other online resources from National Instruments and Freescale, the NI Educational Platform for Microcontrollers with ELVIS II combined with the Freescale MCU SLK is an ideal platform for teaching microcontroller design.

Concepts covered

- Flash memory , debugging and LEDs
- Timers and delays
- Digital I/O
- Interrupts and Timer Overflow
- Input Capture & Function Generator
- Registers and A/D
- Switch de-bounce

Features

- Includes Freescale HCS12 microcontroller board with NI ELVIS platform which integrates 12 most commonly used instruments – including oscilloscope, digital multimeter, function generator, bode analyzer, and more – in a compact form factor
- Freescale CodeWarrior for HCS12 included
- Includes manuals and procedures for complete experiments to teach various concepts in microcontrollers
- Courseware continuously updated with new revisions available for free download
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module

Applicable Courses

- Electronics Engineering
- Computer Engineering
- Embedded Systems

References

- Bahrain Polytechnic
- Khalifa University

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NI Education Platform for Embedded System Design

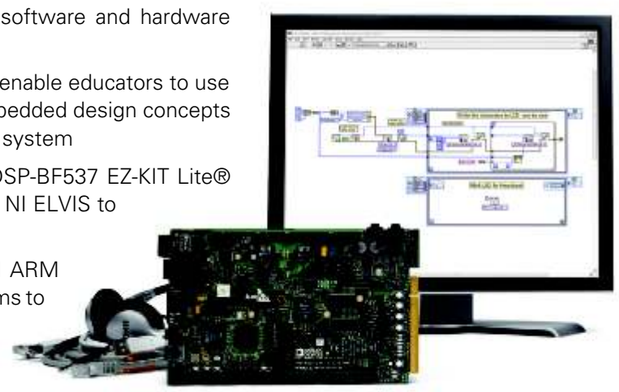
Overview

To empower engineering students from all disciplines to build embedded systems, whether it is for the next-generation solar car or for autonomous vehicles, National Instruments now offers a comprehensive collection of add-on tools that make teaching embedded systems using FPGAs, DSPs, MPUs, or any 32-bit microprocessors easy and affordable.

The National Instruments Education Platform for Embedded System Design helps teach concepts and build embedded systems using field-programmable gate arrays (FPGAs), digital signal processors (DSPs), and 32-bit microprocessors, so engineering students from all disciplines can build sophisticated and powerful embedded systems.

Platforms provided include the following software and hardware systems –

- The Xilinx Spartan 3E XUP hardware to enable educators to use LabVIEW FPGA to teach digital and embedded design concepts and the FPGA based NI Single Board RIO system
- The LabVIEW-compatible Blackfin® ADSP-BF537 EZ-KIT Lite® board which can be integrated with the NI ELVIS to teach concepts of DSPs
- The LabVIEW Embedded Module and ARM Microcontroller based Embedded systems to teach microcontroller programming concepts



Concepts covered

- Embedded Design Methods
- FPGA Programming Techniques, I/O and timing
- Host communication and control
- Code optimization, speed and timing
- HDL code integration
- Introduction to ARM Microcontrollers
- Debugging ARM and Interrupt Driven Programming
- DSPs - Filters, Fourier Transform, Adaptive Filters, FIR, IIR, DTMF and Sample Rate Conversion

Features

- Includes hardware platforms for ARM microcontroller, with Keil Cross compiler, Spartan FPGA based hardware and the Blackfin ADSP board for programming and implementation of algorithms
- All hardware integrates with LabVIEW to allow for an integrated software development environment and easy connectivity to multiple hardware targets
- Includes manuals and procedures for complete experiments to teach various concepts in FPGAs, DSPs and microcontrollers
- Courseware continuously updated with new revisions available for free download
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module

Applicable Courses

- Electronics Engineering
- Signals and Systems
- Embedded Systems
- Control systems

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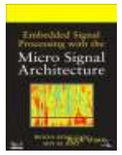

Embedded Signal Processing with the Micro Signal Architecture

Woon-Seng Gan, Nanyang Technological University & Sen M. Kuo, Northern Illinois University

Wiley-Interscience

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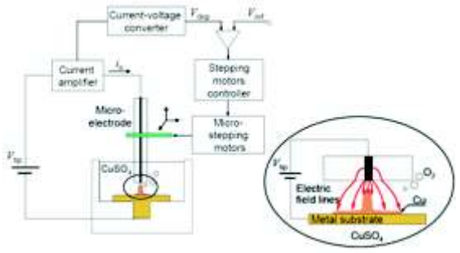
LabVIEW Based System for the Fabrication of Microstructures

Abstract:

LabVIEW is used to specify and control the fabrication of microstructures through the use of localized electro-deposition (LED) technology. In particular, LabVIEW is used to provide a user interface, utilize a USB DAQ to measure the deposition voltage, and control three, electrode tip positioning picomotors for the fabrication of axially-symmetric high aspect-ratio microstructures with controllable cross sectional geometries and dimensions.

Products Used: NI LabVIEW and NI DAQ

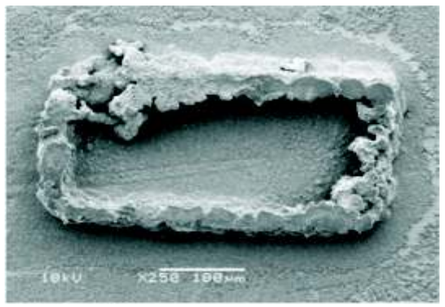
Details: LabVIEW used to compute and implement the particular trajectory by controlling feedback picomotors to set a particular x-y-z electrode tip position. Furthermore, the electrode deposition voltage is measured via the USB-DAQ and used as feedback for the control system.



Localized electro-deposition (LED) is a technique capable of localizing an electrolysis reaction that results in material deposition at a miniature spot determined by the size of an electrode tip. This work proposes the utilization of a synchronized linear displacement strategy of the tip to allow the fabrication of complex microstructures. Thus, an advanced positioning system with an optical encoder based feedback system is used to provide absolute positioning with nanometer accuracy. In particular, a control algorithm is developed to monitor the deposition rate during the entire travel of the tip and synchronize the displacement of the tip according to the progress of deposition at all trajectories.

In order to compare the two proposed LED control systems, the LabVIEW development system is used to rapidly prototype the user interface. The user interface allows the positioning mode (stepping or continuous) to be specified as well as the type of microstructure, electrode voltage, and trajectory displacements and speed. The front panel also displays the electrode geometric position and charts of the measured electrode voltage and position over time.

The electrode voltage measurement is accomplished by a USB DAQ device for robust, accurate, precise voltage measurements. Further, the picomotors utilized optical encoders for feedback mechanism capable of repeatable incremental steps of 63nm, and included LabVIEW VIs for position control. These position VIs were easily converted into subVIs for use in the overall control system VI. This development procedure enabled easy testing of subsystems before integration into the entire control system.



Conclusion:

After thorough testing of the various subsystems, the entire control system was integrated together and, amazingly, constructed a 400 x 200 x 50 m copper rectangle upon the first run of the VI. The VI was then used to research the construction of various other structures of different dimensions, displacement algorithm, and motor speed, all of which was easily set in the front panel.

Author | Dr. Michael Jacobson Faculty of Biomedical Engineering Higher Colleges of Technology United Arab Emirates

Developing a Robotic Manipulator for Cancer Therapy Using Virtual Instrumentation

Abstract:

Developing an automated robotic manipulator for performing photodynamic therapy (PDT) on cancer patients.

Products Used: NI LabVIEW, NI PXI with Motion Control

Details: Using virtual instrumentation to design a robot capable of precise movement and highly accurate placement of PDT therapy When treating cancer, oncologists select from a number of techniques depending on the type and stage of the tumor in question. The most common techniques used today are photodynamic therapy, surgery, radiation therapy, chemotherapy, hormone therapy, and immunotherapy.

PDT is a special form of phototherapy, a term comprising all treatments that use light to induce beneficial reactions in a patient's body. PDT is a new technique capable of destroying unwanted tissue while sparing normal tissue.

During PDT treatment, a drug called a photosensitizer is administrated to the patient by injection. The photosensitizer alone is harmless and has no affect on either healthy or abnormal tissue. However, when light emitted by a laser is directed at the tissue containing the drug, the drug is activated and the tissue is rapidly destroyed precisely where the light has been directed. This technique allows for a focused targeting of the abnormal tissue with careful application of the light beam, which translates into more effective treatment.

The Robot - Automated robotic mechanical manipulator whose primary function consists of skimming along the patient's skin while performing the PDT technique was developed. The robot moves the laser heads over the affected area of the patient's body in certain geometrical designs, such as circular or elliptical shapes, so that the tumor can be destroyed. Achieving a geometrical shape over a patient's body requires five movements - Three translations whose functions are defined as follows - Z provides the vertical control of the treating laser heads & two rotations. To achieve these five movements, five corresponding stepper motors must be controlled by the command signals generated by the command system and delivered by the electrical circuits to the motor drivers.

Command System – LabVIEW directly controls four stepper motors (X, Y, θ, and Φ); a Microchip Technology PICmicro microcontroller controls the fifth motor (Z). The NI 7344 motion controller uses a dual-processor architecture – a central processing unit (CPU) and a digital signal processor (DSP) form the backbone of the motion controller.

Electrical Circuits - In the head of the robot, eight optical on/off sensors detect any object that appears within one centimeter in front of them to allow the distance between them and the surface right below to be revealed. To protect the motion system from physical damage and to detect trajectory limits, each axis uses two physical limit switches, forward and reverse. All the sensors, limit switches, and motor drivers are connected directly to the NI 7334 through an NI UMI-7764 motion interface that enables pin-level connectivity.

Benefits of NI Products - LabVIEW uses icons instead of text lines in the creation of applications, which made software development significantly easier. It also contains a huge library that includes a large number of multipurpose subVIs like FlexMotion that we have used extensively in our software. The NI 7344 motion controller offers the performance and determination needed to solve the most complex motion applications, performing command fulfillment, host synchronization, I/O reaction, and system supervision. We get a smoother move resulting in less abrupt transitions, which both saves time and improves performance.

Author | Houssam Bitar, Lebanese University - Second Branch; Georges Issa, Lebanese University - Second Branch; Assad Kallassy, Lebanese University - Second Branch

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NI Education Platform for Green Engineering

Overview

Green engineering is the process of using hardware and software technologies to reduce our impact on the environment. Through real-world measurement data, we can gain a better understanding of how we are consuming resources and receive insight into ways of improving efficiency, reducing waste, and moving to cleaner alternatives.

A key component of green engineering is the study of renewable energy technologies. The NI Education Platform for Green Engineering is a complete sustainable energy trainer for teaching the fundamentals of solar cells, electrolysis, and hydrogen fuel cell theory. The Green Engineering add-on module extends the functionality of the National Instruments Educational Laboratory Virtual Instrumentation Suite (NI ELVIS) and NI LabVIEW software for solar and hydrogen electricity experiments by offering educators all the required tools (solar cells, fuel cells, curriculum, interface board) needed to teach sustainable energy concepts.

The module comes with a set of prewritten labs to teach both basic and advanced green engineering concepts. The included courseware covers solar cell characteristics, configuration and performance, electrolysis concepts, hydrogen fuel cell use, and example power plant modeling. To supplement the labs, the module provides a comprehensive LabVIEW Virtula Instrument that presents a dashboard for all the exercises in the workbook.

Because the module can be programmed with LabVIEW, educators can create their own labs and customize the system to match their individual learning objectives. The programmable load allows users to create dynamic load conditions, and the 4 V/I meters allow input and output power measurements to be captured and plotted simultaneously for comprehensive, real time analysis

Concepts covered

- Photovoltaic cell characteristics
- Electrolysis
- Maximum Power Point Tracking
- Avogadro's Number
- Series and Parallel Arrangements for Solar Cells
- Hydrogen Fuel Cells

Features

- Based on the NI ELVIS platform which integrates 12 most commonly used instruments – including oscilloscope, digital multimeter, function generator, bode analyzer, and more – in a compact form factor
- Modules comes complete with Hydrogen Fuel Cells, Electrolyzer, Solar Photovoltaic cells, Lux Meter, Current & Voltage Meters, Current & Voltage Sources
- Fully customizable experiments, design your own experiments and create custom problems which require solving
- Includes manuals and procedures for 15 complete experiments to teach various concepts in optical fiber communications and technology
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module

Applicable Courses

- Green Engineering
- Renewable Energy
- Sustainable Energy

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NI Education Platform for Power Quality

Overview

Power quality is the set of limits of electrical properties that allows electrical systems to function in their intended manner without significant loss of performance or life. Power quality plays a major role in affecting reliability of assets and machinery which is an area of great Importance to enterprises. Although power is generated and delivered to facilities at set standards, many disturbances occur that affect the quality of the delivered power, either from the destination facility and/or neighboring ones.

At industrial sites, the main power consumption sources are motors, heaters, and arc furnaces – which can all affect power quality tremendously. Modern electric equipment often use switching power supplies that step up or down the voltage introducing serious decrease in power quality.

The NI Education Platform for Power Quality is based on a widely used set of analysis tools developed for the power and industrial sectors. The student is introduced to power quality measures including: Short Duration Variations, Long Duration Variations, Waveform Distortion, Harmonics, Voltage Fluctuations, and Power Frequency Variations. It is based on the National Instruments CompactRIO system which allows for real-time data acquisition and analysis. A comprehensive course manual is embedded into the software for easy access to ad-hoc theoretical materials during the lab.

Concepts covered

- Power Calculation
- Power Quality Analysis & Measurements
- Effect of Different Loads on Power Quality
- Event Logging & Configuration

Features

- Includes manuals and procedures for complete experiments to teach various concepts related to power quality
- Fully customizable experiments, design your own experiments and create custom problems
- Comprises all required sensors to measure voltage and current
- Easy to use open graphical programming software for acquisition, analysis and presentation of data in a multitude of formats
- Fully compliant with top 3 requirements of ABET (Accreditation Board for Engineering & Technology) – apply knowledge of mathematics, science & engineering, design & conduct experiments as well as analyze and interpret data, and design a system, component or process to meet desired needs within realistic constraints
- Complete menu-driven navigation through the different experiments along with a comprehensive step-by-step lab manual as well as a user manual to understand the different blocks of the module

Applicable Courses

- Electrical Engineering
- Power distribution and transmission

References

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Microelectronic Circuits	Adel S. Sedra, Kenneth C. Smith	ISBN: 0195323033
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